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PHYSICS ABSTRACTS

SECTION A

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SCIENCE ABSTRACTS

SECTION A, PHYSICS

SECTION B, ELECTRICAL ENGINEERING

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VOLUME 57 **OCTOBER 1954** NUMBER 682

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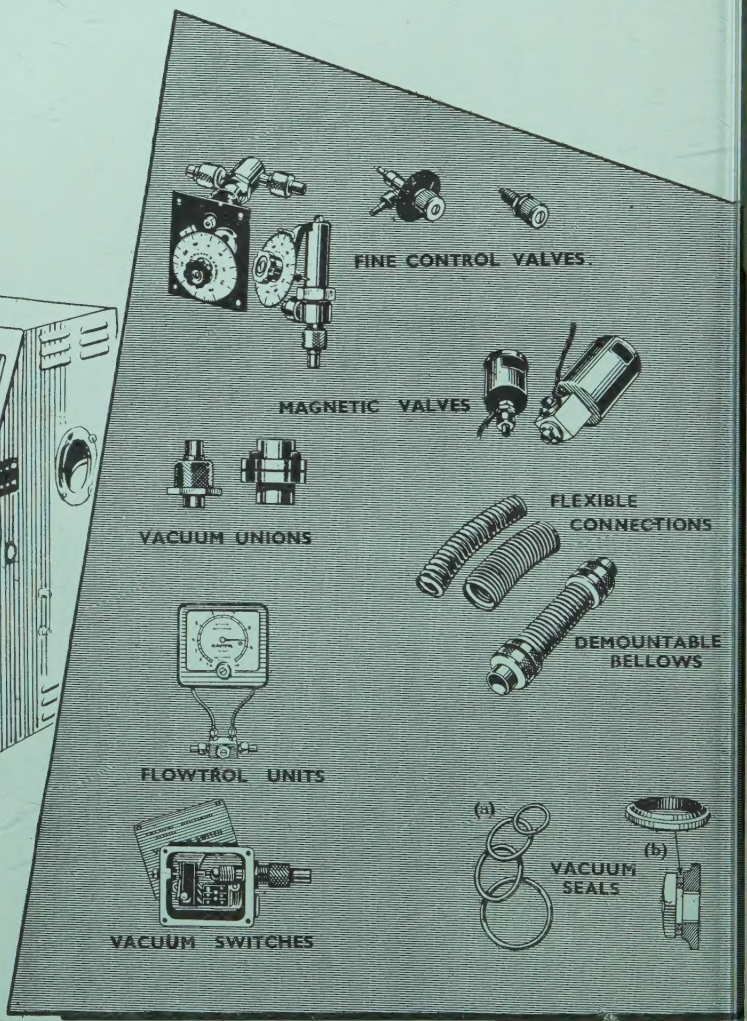

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Electronic relays and counters
Automatic control mechanisms
Applied electrochemistry
Photocells
Thermionic tubes
Cathode-ray tubes
X-ray tubes
Amplifiers
Radiocommunication
Mechanical engineering
Illumination

LIST OF JOURNALS

The following list supplements the List of Journals published with the January number of Volume 56 (1953) and the Supplement published with the Index to Volume 56 (1953). Reprints of the List of Journals (1953) and the Supplement (1953) can be obtained from the Institution of Electrical Engineers, Savoy Place, London, W.C.2, price 2s. 0d. post free.

The addresses given are believed to be correct at the date of publication, but no responsibility can be accepted for errors.

Commonwealth Sci. Industr. Res. Org. Australia, Nat. Stand. Lab. Tech. Pap.	*Commonwealth Scientific and Industrial Research Organization, Australia. National Standards Laboratory Technical Paper.* National Standards Laboratory, University Grounds, Chippendale, New South Wales.
Ned. Tijdschr. Natuurkde.	*Nederlands Tijdschrift voor Natuurkunde.* Bijhouwerstraat 6, Utrecht.
Scientia Electrica	*Scientia Electrica.* S. Hirzel Verlag, Claridenhof, Gotthardstrasse 6, Zurich 2.

New Journals

Commun. and Electronics [*London*]	*Communications and Electronics.* Drury House, Russell Street, Drury Lane, London, W.C.2. Volume 1, Number 1, dated *October*, 1954. Annual subscription 30/- per 12 copies. Note: All references in *Science Abstracts* to *Commun. and Electronics* of date earlier than September, 1954, are to *Commun. and Electronics* [*New York*], which is Part I of *Trans Amer. Inst. Elect. Engrs.*
Control Engng	*Control Engineering.* McGraw-Hill Publishing Company, 330 West 42nd Street, New York 36. Volume 1, Number 1, dated *September*, 1954.

Errata

Abstr. 417 (1954) line 2:	*for* J. KRUMANSL *read* J. KRUMHANSL.
Abstr. 4400 (1954) line 2:	*for* A. W. BRAUN *read* A. E. BRAUN.
Abstr. 4484 (1954):	*for* (1954) *read* (1952, publ. 1954).
Abstr. 7638 (1954) line 15–16:	*for* movements *read* moments.
Abstr. 7763 (1954) line 5:	*for* k_1 and k_2 *read* K_1 and K_2.
Abstr. 8436 (1954) line 3:	*for* VEKHSLER *read* VEKSLER.
Abstr. 8525 (1954) line 4:	*for* $Mg^{25}(\rho, \gamma)Al^{26}$ *read* $Mg^{25}(p, \gamma)Al^{26}$.
Abstr. 8597 (1954) line 10:	*for* (448) *read* (548).
Abstr. 8678 (1954) lines 9 and 10:	*for l–s read l.s.*

Corrections to Articles

Corrections have been published, as shown below, to the articles whose abstract numbers are given. Unless otherwise stated, the volume and page given refer to the journal named in the abstract, i.e. the journal in which the original article was published.

Abstr. 5341 (1952):	**94,** 1801 (*June* 15, 1954).
Abstr. 2605 (1953):	**3,** *No.* 3–4 (1954).
Abstr. 2606 (1953):	**3,** *No.* 3–4 (1954).
Abstr. 2157 (1954):	**26,** 583 (*July*, 1954).
Abstr. 5394 (1954):	**26,** 583 (*July*, 1954).
Abstr. 6202 (1954):	**26,** 583 (*July*, 1954).

MATHEMATICS 51

513.761 : 535.642.1

Invariance of insidedness in projective transformations of the Maxwell triangle. *See Abstr.* 9155.

517.512.4

8827. Asymptotic expansions of Bessel functions in the transitional regions. M. NAGASE. Note in *J. Phys. Soc. Japan*, **9**, 296–7 (*March–April*, 1954).

Expansions are found for $H_\nu^{(1)}(z)$ and $H_\nu^{(2)}(z)$ in the regions where, if $\nu = z\cosh\gamma$, we have $\gamma = 0(z^{-1/3})$. These expansions are useful in the study of the diffraction of waves by a sphere. L. S. GODDARD

517.7

8828. The common elliptic integrals and functions. R. CAZENAVE. *Ann. Telécomm.*, **9**, 103–8 (*April*, 1954) *In French.*

An exposition of the theory, including an historical account. A geometrical interpretation is given of Legendre elliptic integrals, and also an interpretation, via spherical trigonometry, of the Jacobian elliptic functions. L. S. GODDARD

517.942

8829. Round-off errors in relaxational solutions of Poisson's equation. A. R. MITCHELL. *Appl. sci. Res. B*, **3**, *No.* 6, 456–64 (1953).

Formulae are derived for estimating the magnitude of the round-off errors which arise in relaxational solutions of Poisson's equation in one dimension and over rectangular regions. In the latter case, the number of nodes and the mesh ratio are taken as variable parameters. A.

518.5 : 621.317.79

8830. Survey of analog multiplication schemes. C. M. EDWARDS. *J. Assoc. Comput. Machin.*, **1**, 27—35 (*Jan.*, 1954).

518.5 : 621.383 : 621.389

8831. The A.D.E. photo-electric integrator. J. R. LOWE. *Nature* [*London*] **173**, 1222–3 (*June* 26, 1954).

The integrator consists of a photo-plate grating, representing the function to be integrated, placed between a light-diffusing table and a photocell. The photocell ripple current is used as the signal, being rectified and amplified by a factor of 20 000 to provide a galvanometer reading. The surface integral of any function may thus be evaluated over any domain (possibly with irregular boundaries) as defined by the setting of opaque masks. The gratings are prepared by drawing alternate bands of black and white to represent a univariate normal distribution. Two such diagrams superposed photographically at right angles, and reduced, provide the grating: the light energy arriving at the cell, via the unblackened areas, is governed by the binomial distribution function. For a particular case, the standard deviation of the discrepancies between values obtained with the instrument and the calculated values was 0·002. A. J. KENNEDY

519.281.2 : 539.17

8832. Gauss's formula of numerical integration and the design of experiments. P. C. PRICE. Note in *Proc. Cambridge Phil. Soc.*, **50**, *Pt* 3, 491–4 (1954).

A method of experimental design is described. It was found in the design of angular correlation experiments in nuclear physics. It reduces a good deal the amount of computation required in the reduction of the experiment by the method of least squares. For associated work see Abstr. 4095 (1954). L. S. GODDARD

ASTRONOMY . ASTROPHYSICS . GEODESY 52

522.614 : 523.82

8833. Direct measurement of intensity distributions in star images. J. M. NAISH AND P. G. JONES. *Nature* [*London*] **173**, 1241–2 (*June* 26, 1954).

An experimental arrangement is described with which a direct measurement of intensity-distribution, within an artificial star-image $\sim 0{\cdot}0015$ in. dia. formed by a long-focus photographic lens, may be obtained photoelectrically by transverse optical scanning of the image with a slit-probe, 0·00005 in. dia. Adequate response from the photomultiplier is secured by using a condensed high-pressure mercury source. Preliminary measurements with the apparatus indicate that the distribution patterns obtained for the image formed by a 36 in. focus *f*-6·3 telephoto lens conform with the expected general pattern for a lens of this type and focal length. D. R. BARBER

522.9

8834. Systematic study of the disturbance of telescopic images. J. RÖSCH. *J. Phys. Radium*, **15**, S 39–S 42 (*June*, 1954) *In French.*

This study assumes that disturbance of images is due to four main causes. Using an objective of 24 in. aperture at *f* 9·8 placed on the Pic du Midi, observations were made of a bright star (Sirius) photographed through a Hartmann screen and simultaneously by auto-collimation, an artificial source (100 W lamp). Many records were taken, measured and reduced to determine the deformation of the wave surface. The author describes his method of separating the several effects and their relative intensities. E. G. MARTIN

522.92 : 551.593.12

8835. Astronomical "seeing" and its relation to atmospheric turbulence. G. KELLER. *Astron. J.*, **58**, 113–25 (*July*, 1953).

A method is outlined by which it is, in principle, possible to compute the average autocorrelation function of density fluctuations in the earth's atmosphere, assuming that the distribution of light intensity in the "seeing" image of a star is known. The presentation is in two parts, the first being devoted to a qualitative description of the events which occur. The second part contains the mathematical theory. A.

523.11

8836. The stability of cosmological models. W. B. Bonnor. *Z. Astrophys.*, **35**, *No.* 1, 10–20 (1954).

Previous work on the stability of relativistic cosmological models has produced conflicting results. In this paper, the boundary conditions recently given by O'Brien and Synge for surfaces of discontinuity in general relativity are applied to this problem. The method used is to subject the Friedmann model to a distortion which preserves the spherical symmetry and the isotropy of pressure, and which satisfies the boundary conditions. It is found that if the matter present satisfies the same equation of state $p = f(\rho)$ for $t < 0$ and $t > 0$, then the model is not merely stable, but permits no disturbance whatever. If different equations of state exist for $t < 0$ and $t > 0$, then the disturbance implies discontinuities in the pressure and its time derivatives, and results in another, different, Friedmann universe. If there is no equation of state for $t > 0$, inhomogeneities can develop and the stability of the model depends on the precise nature of the deformation; it seems probable that the history of the model for $t > 0$ is completely determined if the pressure and all its time derivatives at $t = 0$ are given. A possible mechanism for the formation of local condensations without general instability is described. Finally, a way in which a contracting Friedmann model could change into an expanding one without passing through a singular state is suggested. A.

523.11

8837. On the elongation of a fluid sphere in a uniform external magnetic field. G. Gjellestad. *Astrophys. J.*, **120**, 172–7 (*July*, 1954).

It is shown that a non-magnetic homogeneous incompressible fluid sphere of infinite electrical conductivity in a uniform external magnetic field will tend to become a prolate spheroid in the direction of the given field. It is further shown that in a magnetic field of the order of 7×10^{-6} gauss in the spiral arm, even the largest clouds ($R \sim 50$ psc) may be appreciably elongated, while smaller clouds will be squeezed into long, thin, rodlike shapes. A.

523.161

8838. Behavior of matter in space. L. Spitzer, Jr. *Astrophys. J.*, **120**, 1–17 (*July*, 1954).

Lecture reviewing interstellar matter studies.

523.161

8839. On "elephant-trunk" structures in the region of *O* associations. E. A. Frieman. *Astrophys. J.*, **120**, 18–21 (*July*, 1954).

A recent theory of Oort and Spitzer indicates that the *O* stars are born in regions of accumulation of interstellar H and further provides a mechanism for the acceleration of the interstellar clouds. It is shown here that the theory leads to the presence of the Rayleigh–Taylor hydrodynamic instability. The "elephant-trunk" structures observed in the region of the *O* associations are interpreted as manifestations of the instability in its asymptotic phase. Calculations are given of the linear dimensions to be expected for these structures and are in agreement with values obtained by measurement of Minkowski's photographs of NGC 2244. A.

523.161 : 523.59

8840. Interplanetary gas. E. J. Öpik. *Z. Astrophys.*, **35**, *No.* 1, 43–60 (1954).

The implications of a recent interpretation of the polarized component of zodiacal light as being due to scattering by free electrons are analysed. Whatever gas is present in interplanetary space, whether indigenous or passing through from interstellar space, it must be completely ionized by corona radiation. If the presence of magnetic fields is disregarded, the following points arise: (1) outside the earth's orbit interplanetary gas would be blown away by the impact of interstellar gas, contrary to the alleged observational evidence; (2) there does not seem to exist an adequate source of angular momentum, which would be required to explain the alleged flattened shape of the surfaces of equal density of the gas. The second point is serious enough to force the assumption of large-scale magnetic fields in interplanetary space; alternatively there may not be any appreciable amounts of interplanetary gas, the polarization being then due to reflection from solid particles. Magnetic fields would inhibit solar accretion of the completely ionized interstellar gas. A.

523.161

8841. Expansion of a finite one-dimensional gas cloud into a vacuum. A. G. Mackie. *Proc. Roy. Soc. Edinburgh A*, **64**, *No.* 4, 57–70 (1954).

An investigation is made of the motion of a one-dimensional finite gas cloud which is initially at rest and is allowed to expand into a vacuum in both directions. The density of the gas at rest is assumed to rise steadily and continuously from zero at the boundaries to a maximum in the interior of the cloud. If the subsequent motion is continuous, it is completely specified by analytical solutions in seven different regions of the x–t plane joined together along characteristics. The motion of one of the boundaries is discussed, and conditions found for it to have (i) an initial stationary period or (ii) a final constant velocity of advance into the vacuum. The gas streams in both directions from a dividing point at zero velocity. This point ultimately tends to the mid-point of the initial distribution. The possible breakdown of the continuity of the motion is discussed, and a condition on the initial density distribution found for shock-free flow to be maintained. A.

523.161 : 523.877

8842. Application of the virial theorem to some astronomical problems. S.-S. Huang. *Astron. J.*, **59**, 137–42 (*May*, 1954).

The virial theorem has been applied to the study of the equilibrium configuration and the stability of interstellar clouds. It is found that for a given total mass and a given negative total energy the cloud has always a stable equilibrium configuration and that the interstellar clouds actually observed are in, or very near to, the state (specified by temperature, density and size) of the stable equilibrium. An equation governing the change of the equilibrium configuration through some slow processes of energy transfer with outside is derived and the effect of rotation on the equilibrium configuration is investigated. Ledoux's method of applying the virial theorem to the problem

of pulsating stars has also been generalized, and a general formula derived for the period of pulsating stars. A.

523.165

8843. A radio survey of the Milky Way in Cygnus, Cassiopeia and Perseus. R. H. Brown and C. Hazard. *Monthly Not. Roy. Astron. Soc.*, **113**, *No.* 2, 109–22 (1953).

A survey has been made of the radio emission from a section of the Milky Way extending from $l = 40°$ to $l = 130°$ and $b = +14°$ to $b = -14°$. The measurements were made at a frequency of 158·5 Mc/s using an aerial with a 2-degree beam. The isophotes and the absolute intensity of the radiation from the region have been obtained. The greater sensitivity and resolving power of the equipment over that used in previous work has revealed some new features of the region, including several localized sources not reported previously. It has also been possible to obtain detailed contours for the region of high intensity close to the intense source Cygnus I. A.

523.165

8844. A survey of 23 localized radio sources in the northern hemisphere. R. H. Brown and C. Hazard. *Monthly Not. Roy. Astron. Soc.*, **113**, *No.* 2, 123–33 (1953).

A survey has been made of the radio emission from a limited region of the northern hemisphere using a pencil beam 2° wide at a wavelength of 1·89 m. The co-ordinates and intensities of 23 localized sources have been measured. Their distribution shows a marked concentration of the intense sources around the galactic plane. The distribution of the weaker sources cannot be inferred from the survey, but from the results of other surveys it is believed that their distribution is more nearly isotropic. It is concluded that the intense sources represent a class of rare objects in the Galaxy which lie close to the galactic plane. The data at present available are not sufficient to decide whether the weak sources also lie inside the Galaxy; however, there is some evidence to show that a number of these sources are extra-galactic. A.

523.165

8845. Galactic radiation at radio frequencies. VII. Discrete sources with large angular widths. J. G. Bolton, K. C. Westfold, G. J. Stanley and O. B. Slee. *Austral. J. Phys.*, **7**, 96–109 (*March*, 1954).

For Pt VI, see *Austral. J. Phys.*, **6**, 420–33 (Dec., 1953). Observations with three forms of equipment have revealed the existence of a number of sources of angular width more than 1°. A rough analysis of the brightness distribution of one source shows that it is elongated along a parallel of galactic latitude. This source appears to be typical of a class that is generally distributed around the galactic equator, and may represent fine structure in the distribution of radiation from the Galaxy. Of the others, one appears to be associated with the abnormal galaxy NGC 5128, and another has been identified with a network of gaseous filaments in our own Galaxy. A.

523.165

8846. Galactic radiation at radio frequencies. VIII. Discrete sources at 100 Mc/s between declinations + 50° and −50°. J. G. Bolton, G. J. Stanley and O. B. Slee. *Austral. J. Phys.*, **7**, 110–29 (*March*, 1954).

One hundred and four discrete sources have been found from a survey covering declinations + 50 to −50°. The individual sources are compared in position and flux density with those of previous surveys. The observed distribution shows the concentration of sources of all brightnesses to the galactic equator found by Brown and Hazard (1953) and the concentration of the bright sources to the equator found by Mills (1952). A new concentration of faint sources is evident in the southern galactic hemisphere. There is strong evidence for departures from a homogeneous isotropic distribution for the sources outside a 20° zone about the galactic equator. Ten identifications between sources and visible objects are suggested; seven of these are between faint sources and extragalactic nebulae of photographic magnitude about 12·5, and three with galactic nebulosities. One of the latter is the expanding shell of Nova Aquila 1918. A.

523.165

8847. Observations of the general background and discrete sources of 18·3 Mc/s cosmic noise. C. A. Shain and C. S. Higgins. *Austral. J. Phys.*, **7**, 130–49 (*March*, 1954).

A survey of a broad strip of the sky, centred on Dec. −32°, has been made at a frequency of 18·3 Mc/s using an aerial with an overall beam width to half-power of 17°. Previous results concerning the background distribution of brightness have been confirmed and 37 discrete sources have been detected. The distribution of these sources shows some galactic concentration; it becomes homogeneous if sources within 18° of the galactic plane are excluded. From observations of source scintillations, it is concluded that some of the discrete sources have angular sizes of the order of 1°. No correlation was found between the occurrence of scintillations and published ionospheric data, but the observations are consistent with an origin of the scintillations in irregularities, of dimensions about 4 km, at a height of about 500 km. A.

523.165

8848. A comparison of the intensities of cosmic noise observed at 18·3 Mc/s and at 100 Mc/s. C. A. Shain. *Austral. J. Phys.*, **7**, 150–64 (*March*, 1954).

A comparison is made of the intensities of the radiation, from the general background and from the discrete sources, which have been measured at 18·3 Mc/s and at 100 Mc/s. It is shown that the ratio of brightness temperatures at 18·3 Mc/s and 100 Mc/s is roughly constant (about 120) for different directions of observation except near the galactic equator where low values are generally observed, the ratio being a minimum near the galactic centre. Also, for the discrete sources observed at the two frequencies there is a wide scatter in the ratio of the flux densities at the two frequencies, with a possible grouping of the sources around flux density ratios of 6 and 60. From these results the following conclusions are drawn: absorption in interstellar gas can account for the variations in the ratio of background brightness

temperatures; extragalactic sources comprise a subclass of Mills's class II and may account for the polar component of the background radiation; the background radiation is not due to radiation from sources of the type so far observed. A.

523.165

8849. Observations of the 21 cm line from the Magellanic Clouds. F. J. KERR, J. V. HINDMAN AND B. J. ROBINSON. *Austral. J. Phys.*, **7**, 297–314 (*June*, 1954).

A survey has been made of the 21 cm line from neutral interstellar hydrogen in the Magellanic Clouds. These are the first observations of this radiation from an extragalactic source. The observations show that neutral hydrogen extends well beyond the easily visible regions of each Cloud, the gas being in each case less concentrated towards the nucleus than are the bright stars. From the total radiation received, the masses of neutral hydrogen are calculated to be 6×10^8 and 4×10^8 solar masses for the Large and Small Cloud respectively. Since the Small Cloud is believed to contain much less dust, this means that the ratio of gas to dust is very different in the two systems. The measurement of Doppler frequency shifts has yielded extensive new information about radial velocities within the Clouds. The velocity distribution indicates that both Clouds are rotating. Detailed discussion of the velocities has been deferred for subsequent publication. A.

523.165

8850. A method for the measurement of the distance of radio stars. D. R. W. WILLIAMS AND R. D. DAVIES. *Nature* [*London*] **173**, 1182–3 (*June* 19, 1954).

The possibility of determining the distances of radio stars from the degree of absorption by interstellar hydrogen of the star's radiation in the neighbourhood of the 21 cm line is examined. Oort's model of the Galaxy is used for distance calibration. The method has been applied to the Cygnus source (distance >9500 parsecs) and the Cassiopeia source (distance between 500 and 2500 parsecs). M. W. OVENDEN

523.165 : 522.6 : 621.317.79

8851. Multiple element interferometer for locating sources of solar noise at 4000 Mc. H. TANAKA AND T. KAKINUMA. *J. Phys. Soc. Japan*, **9**, 364–8 (*May–June*, 1954).

With the intention of locating sources of radio noise from the disturbed sun at 4000 Mc/s, an interferometer with 5 aerials was constructed. Each aerial has a paraboloidal reflector of size 1·5 metre in diameter, which can be rotated equatorially. They are placed in E-W direction at 6 m intervals. The main lobes are 43′ apart and each lobe has a half-power width of 7·8′. Each aerial is connected to the radiometer with waveguides and magic *T*. General design principles and the results of observations are described in this paper. The experimental record pattern, when the sun is quiet, does not agree with the calculated one corresponding to uniform distribution over the optical disk. From the eclipse observation, it is concluded that the radio disk is about 1·06 times larger than the optical disk. The experimental record pattern is obtained if the outer region is about 2·5 times brighter than the optical disk of uniform temperature about $1\cdot9\times10^{4\circ}$K. A.

523.165 : 522.6 : 621.317.79

8852. A new type of interferometer for use in radio astronomy. R. H. BROWN AND R. Q. TWISS. *Phil. Mag.*, **45**, 663–82 (*July*, 1954).

A new type of interferometer for measuring the diameter of discrete radio sources is described and its mathematical theory is given. The principle of the instrument is based upon the correlation between the rectified outputs of two independent receivers at each end of a baseline, and it is shown that the cross-correlation coefficient between these outputs is proportional to the square of the amplitude of the Fourier transform of the intensity distribution across the source. The analysis shows that it should be possible to operate the new instrument with extremely long baselines and that it should be almost unaffected by ionospheric irregularities. A.

523.53

8853. The radio echo from the head of meteor trails. I. C. BROWNE AND T. R. KAISER. *J. atmos. terrest. Phys.*, **4**, 1–4 (*Sept.*, 1953).

A theoretical account in terms of familiar diffraction theory is offered in explanation of a type of radio echo, apparently originating at the moving head of a meteor trail, which is sometimes observed in addition to the well-known specularly reflected echo. No assumptions are invoked beyond those commonly accepted as necessary to explain the specularity reflected echo. The theory predicts intensities of head echoes in agreement with observation, and also predicts that the intensity of the head echo relative to that of the specularly reflected echo should be proportional to the radio wavelength and inversely proportional to the difference in range between the two echoes. It is suggested that other anomalous meteor echoes may arise from discontinuities associated with visual flares. A.

523.53

8854. Radio determination of the velocity and radiant of the Delta Aquarid meteors. D. W. R. MCKINLEY. *Astrophys. J.*, **119**, 519–30 (*May*, 1954).

Several selection principles are applied to separate δ Aquarid shower meteors from background meteors and from other showers with nearby radiants, using radio-echo data obtained on July 26–29, 1949. The observed mean velocity of the δ Aquarid meteors was $40\cdot20 \pm 0\cdot1$ km/sec, and the radiant co-ordinates R.A. $339^\circ \pm 2^\circ$, dec. $-17^\circ \pm 2^\circ$. Two nearby radiants were found; the stronger of these was located at R.A. $340^\circ \pm 5^\circ$, dec. $0^\circ \pm 5^\circ$, with a mean meteor velocity of $41\cdot0 \pm 0\cdot5$ km/sec. Delta Aquarid meteors were also observed on July 18–20, 1949, with a mean velocity of $40\cdot3 \pm 1$ km/sec, radiant at R.A. $342^\circ \pm 5^\circ$, dec. $-15^\circ \pm 5^\circ$, and with rates about one-fifth the July 26–29 rates. It is suggested that speculations about the history of the shower, based on data available up to the present, would be of dubious value. A.

523.72

8855. A study of the solar noise at 3300 Mc/s. M. ODA AND T. TAKAKURA. Note in *Rep. Ionosphere Res. Japan*, **5**, 99–100 (*June*, 1951).

523.72

8856. The solar internal opacity and constitution. I. EPSTEIN AND L. MOTZ. *Astrophys. J.*, **120,** 156–8 (*July*, 1954).

A model solar interior, based on the assumption that the energy is generated by both the proton-proton and the carbon cycles, is calculated with the aid of opacity formulae which include the effects of metals, electrons and hydrogen. The equilibrium model, self-consistent in the opacity, obtained by an iterative process in a double eigen-value problem, is characterized by $X = 93{\cdot}1\%$, $Y = 6{\cdot}7\%$ and $Z = 0{\cdot}2\%$. The central temperature of this model is 12 850 000°, while the density is 98. A convective core exists to the extent of about 8% of the solar radius. This core includes 4% of the mass and has generated within it 29% of the total energy. The proton-proton reaction is found to provide all the energy generated in this model. A.

523.72

8857. Thermal radio emission from the sun and the source of coronal heating. J. H. PIDDINGTON AND R. D. DAVIES. *Monthly Not. Roy. Astron. Soc.*, **113,** *No.* 5, 582–96 (1953).

Measurements of thermal solar radio noise confirm the existence of a hot corona and indicate the presence of even hotter regions above sunspots. These regions are proposed as a source of coronal energy and their properties investigated. Radio data extending over a period of several years are statistically analysed to separate the total radiation into two components, one associated with sunspots and the other showing no such connection. The following conclusions are reached: (*a*) The sunspot radiation and the very hot regions responsible for it diminish less rapidly than the spot area and exist for a month or more after the spot has vanished. (*b*) For this and other reasons, the non-spot or "basic component" at some frequencies is much lower than previously believed. Its actual value is uncertain but it is thought that if spots were absent for many months, most of the radiation would cease. (*c*) This is interpreted as showing that the corona, at least during the period 1947–1951, was mainly due to an agency appearing with sunspots and providing fresh hot gases above the spots. These gases remained after the spots vanished, spreading out to replenish the corona. They appear capable of completely replacing the corona every four days or so. A.

523.72

8858. The distribution of radiation across the solar disk at metre wave-lengths. P. A. O'BRIEN. *Monthly Not. Roy. Astron. Soc.*, **113,** *No.* 5, 597–612 (1953).

Measurements of the distribution of radio "brightness" across the solar disk have been made at wavelengths of 1·4, 3·7 and 7·9 m, using interferometers of variable aperture. The size of the emitting disk was observed to increase with increasing wavelength, the averaged equivalent temperature being reduced to 10% of its central value at radii of $1{\cdot}6\ R_0$, $2{\cdot}2\ R_0$ and $2{\cdot}8\ R_0$ for the wavelengths 1·4, 3·7 and 7·9 m respectively. At 1·4 m, using interferometers with axes inclined at various angles to the solar axis of rotation, it was shown that the shape of the sun was approximately elliptical; the radial distance at which the brightness temperature was reduced to half was about 25% greater at the equator than in the polar direction. A.

523.72

8859. Solar radio emissions at 4-metres wave-length during 1947–50 inclusive and their relation to solar activity. J. S. HEY. *Rep. No.* 372 *R.R.D.E.* (*now R.R.E.*), *Ministry of Supply, Malvern.* Abstract in *Monthly Not. Roy. Astron. Soc.*, **113,** *No.* 5, 653 (1953).

Bursts at 4·1 m wavelength of solar radio emission of duration exceeding $\frac{1}{4}$ min and intensity greater than 2×10^{-21} watt m^{-2} $(c/s)^{-1}$ are analysed with respect to solar flares in order to determine (1) time differences between flares and radio bursts and (2) the distribution on the solar disk of flares with associated radio bursts. There is a tendency for the onsets of the bursts to lag behind the onsets of the flares; the records of radio intensity, with rapid and spasmodic fluctuations in amplitude, make it difficult to determine onset precisely, but the median lag of bursts behind the flares is about a minute or two. The median lag of the maxima of the bursts behind the flares is also about a minute. It is pointed out, however, that both for onsets and maxima the dispersion of the distribution of time differences between flares and bursts is such that a very appreciable proportion of the radio bursts precede the flares. The analysis of time differences is extended to ionospheric phenomena associated with flares. The distributions all show considerable dispersion, and it appears that there are secondary controlling factors both in the solar phenomena and in the ionosphere with varying influence on any individual occurrence. The analysis of the occurrence of radio bursts with respect to solar longitude from central meridian helps to confirm the previous tentative conclusion that there is a greater chance of radio bursts in association with flares on the eastern half of the visible solar disk than for flares on the western half. The asymmetry occurs in the observations for each year and the statistical significance becomes increasingly evident. A.

523.72

8860. Contribution of the study of the sun's electromagnetic radiation on decimetre waves. M. LAFFINEUR. *Bull. astron.* [*Paris*] **18,** *No.* 1, 1–57 (1954) *In French.*

From 1948 to 1950 a series of measurements of the solar radiation in the region of radio wavelengths were made at the Meudon Observatory. Because of the intense solar activity during that period a great number of bursts of radiation were observed. Observations at 555 and 255 Mc/s are described and compared with visual and photographic observations. They suggest a directed emission from the spots. A.

523.72

8861. Solar flares and associated 2800 Mc/sec (10·7 cm) radiation. H. W. DODSON, E. R. HEDEMAN AND A. E. COVINGTON. *Astrophys. J.*, **119,** 541–63 (*May*, 1954).

Study of 2800 Mc/s solar radiation at the time of 213 flares and 173 subflares has shown distinctive radio events associated with 57% of the flares and 19% of the subflares. The flare-associated distinctive events at 2800 Mc/s can be described by essentially the same types and categories already used to report out-

standing disturbances at this radio frequency: single bursts; single-simple bursts with and without a post-burst increase; single-complex bursts with and without a postburst increase; gradual rises and falls of flux. In addition, there is the designation "null," or no distinctive event. There is strong evidence that there is an outstanding event or disturbance in 2800 Mc/s solar radiation only when a flare or subflare is in progress. Time relationships between Hα flares and 2800 Mc/s events suggest that two quite different types of phenomena may be represented in the flare-associated 2800 Mc/s radiation. One is a sudden burst-type feature which occurs during the rise to maximum of the Hα flare. The other is the more gradual rise and fall of flux and "postburst increase," which lasts as long as, or longer than, the flare itself. Both types of phenomena appear to start with the Hα flare. Flares associated with large "postburst increases" or "gradual rises and falls" show a high concentration toward the central part of the solar disk. This is not the case for the strictly "burst-type" disturbances. The importance of the flare, the position of the flare on the solar disk and accompanying ionospheric disturbances are considered with respect to the form and energy excess of the associated events at 2800 Mc/s. A.

523.72

8862. Intensity measures of calcium *plages* for comparison with 10·3-centimeter solar radiation, October 16, 1951. H. W. DODSON. *Astrophys. J.*, **119,** 564–8 (*May*, 1954).

Photometric studies of K_{232} spectroheliograms for Oct. 16, 1951, are compared with Covington's records of the positions of 10·3 cm (2800 Mc/s) emissive regions on the sun for the same date. There were three emissive regions at 10·3 cm, and there were three maxima in the east-west distribution of calcium *plage* intensity on the solar disk. Sunspots were observed in only two of the three regions. A.

523.72

8863. Brightness of the solar disk at a wave length of 10·3 cm. A. E. COVINGTON AND N. W. BROTEN. *Astrophys. J.*, **119,** 569–89 (*May*, 1954).

A slotted waveguide array, 150 ft long, has been constructed for operation at a wavelength of 10·3 cm and produces a fan-shaped radiation pattern with a resolving power of 0·130° in the narrow dimension. The sun is scanned by the earth's rotation and the resulting drift-curves can be interpreted in terms of a radio disk with bright regions that partake of the solar rotation. Analysis for 1952 shows that the radio disk has a bright ring at the limb of the photospheric disk with an intensity twice that of the central region. The equivalent temperature of the centre of the radio sun is 21 800°K, while the radius of the radio disk is 1·15 times that of the visible sun. The radio-emissive regions have been located within strips, and the analysis for one day, Oct. 16, 1951, shows that there were one intense and two weaker radio spots. Comparison with sunspot data assembled by the Naval Observatory shows that sunspots can be associated with the intense radio spot and with one of the adjacent weaker radio spots, but none can be found for the third. Comparison with spectroheliograms taken at the McMath–Hulbert Observatory shows that a distinct *plage* can be associated with each of the three radio-emissive regions. A.

523.72 : 534.222.2

8864. Space charge wave amplification in a shock front and the fine structure of solar radio noise. H. K. SEN. *Austral. J. Phys.*, **7,** 30–5 (*March*, 1954).

The Mott–Smith [Abstr. 6801 (1951)] interpolation method gives a non-Maxwellian velocity distribution for the particles in a shock front. The dispersion equation corresponding to the non-Maxwellian distribution is derived by Vlasov's (1945) formula. The roots of the dispersion equation indicate frequency bandwidths of space charge wave amplification that decrease with the shock strength. It is suggested, in agreement with Denisse and Rocard (1951), that the storm bursts of narrow bandwidth originating in shock fronts constitute the elementary fine-structure components of solar radio noise bursts. A.

523.746 : 538

8865. The polarity of the sun's magnetic field and the Richardson–Schwarzschild oscillation. H. W. BABCOCK. Note in *Astrophys. J.*, **119,** 687–8 (*May*, 1954).

In their recent paper on the analysis of the motions in heliographic latitude of a large number of sunspots, Richardson and Schwarzschild [*Convegno Volta, Accad. naz. dei Lincei, Rome, p.* 228 (1953)] concluded that the observed displacements should distort a permanent dipole-like field, producing toroidal magnetic fields opposite in sign in the northern and southern hemispheres, and changing sign every 11 years. They stated that such fields would have just the right characteristics to be thought of as the large-scale fields from which the magnetic fields of sunspots could arise by local perturbations, provided that the general field of the sun has the proper polarity. Babcock now points out that, indeed, the observed magnetic polarities of sunspots as predicted by the Richardson–Schwarzschild oscillation are in accord with the positive magnetic polarity as reported for the sun from observations with the new solar magnetograph during the last 18 months. A. BEER

523.75

8866. A family of solutions of the magneto-hydrostatic problem in a conducting atmosphere in a gravitational field. J. W. DUNGEY. *Monthly Not. Roy. Astron. Soc.*, **113,** *No.* 2, 180–7 (1953).

Quiescent solar prominences appear to be in static equilibrium and it is believed that magnetic fields play an essential role; the electromagnetic force must balance the resultant of the pressure gradient and the force of gravity. The static equation for an isothermal atmosphere is derived and a simple family of two-dimensional solutions is obtained. This consists of a set of lines of force such that any magnetic field with these lines of force can be in static equilibrium. A model is obtained which resembles a filament and its associated coronal arches. A.

523.75

8867. Theories of solar phenomena depending on sunspot fields moving in the chromosphere and corona. J. H. PIDDINGTON. *Monthly Not. Roy. Astron. Soc.*, **113,** *No.* 2, 188–97 (1953).

Numerous theories of solar phenomena depend on electric fields induced in the solar atmospheres by the

movement of sunspot magnetic fields. These include theories of flares (Giovanelli's), prominences, cosmic rays and sunspot radio noise. They do not take account of mechanical reactions between the magnetic fields and the conducting gas; when this is done the theories are found untenable. A.

523.75

8868. Magnetohydrodynamic waves under the action of the Coriolis force. B. LEHNERT. *Astrophys. J.*, **119,** 647–54 (*May*, 1954).

In the sun, magnetohydrodynamic waves with wavelengths larger than about a hundredth of the solar radius will be strongly influenced by the Coriolis force if a dipole field with a polar strength of less than 25 gauss is assumed. For small amplitudes, a plane Alfvén wave will be split up into two circularly polarized, transverse waves, travelling with velocities C_1 and C_2 in the direction of the wave normal and with moduli $|C_1| > |V_z| > |C_2|$, where $V_z = V\cos\psi$, $V = B(\mu\rho)^{-1/2}$ being the Alfvén velocity and ψ the angle between the wave normal and the magnetic field, B. Further, there is no equipartition between the kinetic and the magnetic energies. These facts will modify Alfvén's theory of sunspots as far as the periods are concerned; and disturbances of large linear dimensions will be distorted, owing to dispersion. Alfvén's conclusions based on the geometry of the solar magnetic field and his hypothesis on the creation of disturbances due to the presence of instability regions in the solar core are not affected by the discussion of this paper. A.

523.75

8869. Active region prominences and the yellow coronal line. F. P. DOLDER, W. O. ROBERTS AND D. E. BILLINGS. *Astrophys. J.*, **120,** 112–17 (*July*, 1954).

Regions of the sun characterized by emission of the rarely observed yellow coronal line λ5694 were found to be positively associated with the following characteristic behaviour of prominences at the same location: (*a*) large numbers of associated surge-type prominences; (*b*) predominance of scattered knots; (*c*) formation of continuous streamers; (*d*) downward motion of knots and streamers toward an active centre; and (*e*) sharp curvatures and focusing effects in trajectories. On the other hand, the principal observed characteristics of quiescent solar prominences were found to be negatively associated with the regions of yellow coronal-line emission. A.

523.75 : 538.12

Twisted magnetic fields in conducting fluids. *See Abstr.* 9376

523.752

8870. Recent studies of chromospheric spicules. J. H. RUSH AND W. O. ROBERTS. *Austral. J. Phys.*, **7,** 230–43 (*June*, 1954).

Five spicule film sequences taken on different dates in Hα were studied. Maximum heights of spicules ranged downward from 20 000 km. Lifetimes ranged from the film limit of 0·3 min to about 30 min. Distributions of maximum heights and lifetimes indicated the occurrence of numerous small, short-lived spicules that were not resolved in these films. The mean upward velocity of the larger spicules was 31 km/sec, with a broad distribution. The absence of evidence of gravitational deceleration, together with a correlation between individual velocities and maximum heights above the chromosphere, suggests a modified interpretation of the spicule process. The data yield a tentative upper limit to the number of spicules on the entire sun of $2{\cdot}2\times10^4$. A.

523.755 : 539.153

The continuous radiative absorption cross section of Fe XIV and the coronal temperature. *See Abstr.* 9528

523.77

8871. A revised analysis of the solar spectrum from 2990 to 2635 Å. N. L. WILSON, R. TOUSEY, J. D. PURCELL, F. S. JOHNSON AND C. E. MOORE. *Astrophys. J.*, **119,** 590–612 (*May*, 1954).

New solar spectra from 2990 to 2635 Å, obtained from spectrographs flown in rockets on Feb. 9, 1950, Sept. 3, 1952, and Dec. 15, 1952, are presented and analysed. Lines as close as 0·3 Å were observed. Nearly 500 lines are recorded and are attributed to 1054 atomic lines. The detailed spectral-intensity distribution-curve is presented instead of the customary visual-intensity estimates. The effect of instrumental blending is illustrated by comparing a long wavelength region of the rocket spectrum with the high-resolution Utrecht Atlas curve, after averaging the latter over appropriate wavelength intervals. A.

523.77

8872. The width of Hα in solar flares. L. GOLDBERG, H. W. DODSON AND E. A. MÜLLER. *Astrophys. J.*, **120,** 83–93 (*July*, 1954).

It is shown that the observed large widening, at or near maximum, of the Hα emission line in certain solar flares can be explained as a consequence of radiation damping and the high abundance of two-quantum H atoms in the line of sight. When the effective width of the Hα line is calculated according to the theory of self-absorption, the assumption of radiation damping leads to agreement with the observed lines widths when the number of two-quantum H atoms lies in the approximate range 10^{15}–10^{16} per cm^2 in the line of sight. If it is assumed that the lateral extension of a flare is large compared with its thickness, the theory predicts that the effective width of Hα should be proportional to the square root of sec θ, where θ is the angular distance from the centre of the solar disk. Study of the Hα line widths of 610 flares for the period January, 1949, through June, 1952, reveals that the average line width increases steadily with increasing central meridian distance of the flares. Furthermore, flares with exceptionally wide lines ($\geqslant 4{\cdot}0$ Å) are observed most often in flares 45° or more from the central meridian. The relation between effective line width and central intensity found by Ellison is explained as primarily a consequence of self-absorption. Finally, the existing observational evidence in favour of the Stark effect as an important cause of the line broadening is examined and found unconvincing. A.

523.775.1

8873. Emission in hydrogen Balmer lines and continuum in flash spectrum of 1952 total solar eclipse at Khartoum, Sudan. R. G. ATHAY, D. E. BILLINGS, J. W. EVANS AND W. O. ROBERTS. *Astrophys. J.*, **120,** 94–111 (*July*, 1954).

The integrated intensities of the hydrogen Balmer

lines from H8 to H31 and at four wavelengths in the Balmer continuum were measured at two points on the east limb on seventeen ultraviolet spectrograms; and the intensities of Hβ, Hγ and Hδ were measured at one of these points on nineteen visible spectrograms. The observations extend from 100 to 6300 km, with a height resolution of 108 km throughout most of the low chromosphere. Preliminary interpretation of the line intensities revealed that the effects of self-absorption were pronounced and also demonstrated that there were large departures from thermodynamic equilibrium, in the sense that the b_n's were greater than 1 at 1000 km and increased with height. A preliminary interpretation of the continuum data gave a chromospheric model characterized by a large increase of temperature with height and a relatively low electron-density gradient. A.

523.82

8874. Early-type stars in the direction of the galactic center. W. A. HILTNER. *Astrophys. J.*, **120,** 41–7 (*July*, 1954).

A group of *OB* stars in the direction of the galactic centre has been observed for polarization, colour-magnitude and spectral type. The stars as a group have a distance modulus of 12·4 mag. or 3·0 kiloparsecs. The group is probably associated with a spiral arm inside the one isolated at 1·4 kiloparsecs from the sun. One star, HD 164019, located on a star cloud, appears to be more distant than all the others. The observed $m - M_0$ is 14·6 mag. and has an absorption of only 1·7 mag. The interstellar polarization is greatest for the more highly reddened stars. The relationship of the observed polarization and the visible obscuring clouds is well established. However, the distance of the obscured cloud is still in doubt. A.

523.841.372

8875. The measurement of reddening in cepheids. R. CANAVAGGIA. *C.R. Acad. Sci.* [*Paris*] **238,** 2390–2 (*June* 21, 1954) *In French.*

A method is outlined for the evaluation of the amount of interstellar reddening associated with a cepheid relative to another cepheid having the same intrinsic reddening. The method is based on colour indices (derived from 6-colour magnitudes, the sixth standard colour, U, being omitted) which for a cepheid are found to be nearly linear functions of one another; and is illustrated by reference to the reddened supergiant, η Aql. using δ Cep. as the comparison star. D. R. BARBER

523.852.22

8876. Photoelectric spectrophotometry of planetary nebulae. W. LILLER AND L. H. ALLER. *Astrophys. J.*, **120,** 48–57 (*July*, 1954).

Photoelectric spectrophotometric measures of the N_1, N_2 and Hβ line intensities in twelve bright planetary nebulae have been made with the aid of the 10° objective prism on the Curtis Schmidt telescope. The absolute surface brightnesses are in good accord with results obtained by the filter photoelectric method. The mean N_1/N_2 intensity ratio is 3·03, while the $(N_1 + N_2)/H\beta$ intensity ratios are in excellent agreement with those found previously by MacRae and Stock and substantiate the photographic photometric measures made some years ago by one of the authors. The electron densities range from 10^3 to about 2×10^4 electrons/cm^3; they are of the same order of magnitude as those found some years ago by Menzel and one of the authors. The electron temperatures fall between 8000° and 20 000°K and show no strong correlation with the Zanstra temperature of the central star. This lack of correlation is in accordance with recent theoretical expectations. A.

523.872 : 535.243 : 535.342

On an error in measurements of equivalent widths. *See Abstr.* 9077

523.877

8877. Radial pulsations of the two stellar models. L. D. CHATTERJI. *Proc. Nat. Acad. Sci. India A*, **21,** *Pt II*, 118–25 (1952).

Radial oscillations of the two stellar models in which the density is proportional to (1) $1 - r/R$ and (2) $1 - r^2/R^2$, respectively, are considered. A method as developed by Ledoux and Pekeris using Rayleigh's principle is applied to find the periods of the fundamental mode of oscillation for both the models. It is found that the method gives in the first case a lower value for the fundamental period, while in the second case better result for the fundamental period is obtained. The period and amplitude of oscillation for the first model is also determined. A.

523.877

8878. On the magnetic oscillations of a gravitating liquid star. C. PLUMPTON AND V. C. A. FERRARO. *Monthly Not. Roy. Astron. Soc.*, **113,** *No.* 5, 647–52 (1953).

The oscillations of a gravitating liquid star in the presence of a central magnetic pole are considered, and it is shown that the reduction in the periods of the various modes of oscillation derived in an earlier paper [Abstr. 4134 (1954)], in which gravitational forces were neglected, is not as great as was expected. The results are discussed in relation to the oscillation theory of magnetic variable stars. A.

523.877

8879. The rate of accretion of matter by stars. W. H. MCCREA. *Monthly Not. Roy. Astron. Soc.*, **113,** *No.* 2, 162–79 (1953).

It being generally agreed that the present very luminous stars have existed as such for only a small fraction of the past life of the Galaxy, it becomes important to decide whether they are produced from previously existing stars by the accretion of interstellar matter, in accordance with the views of Hoyle and others, or are the result of some continuing process of star formation. It is emphasized that accretion on the scale required need be only a rarely occurring phenomenon. Even so, the quantitative requirements as usually discussed do present difficulties. It is here found, however, that accretion on this scale would take place, if at all, only after a star has been reduced almost to rest relative to surrounding interstellar matter as a result of the retardation produced by such matter. This and other effects that have to be considered in a full discussion of the problem reduce the requirements to ones that seem likely to be found realized in actuality. The main purpose of the present work is to estimate these requirements; the frequency of their realization will be discussed else-

where. The accretion theory has naturally to account not only for the mass-increment but also for its production at a rate sufficient to compensate the transmutation of hydrogen in the stars concerned. It is shown that no additional difficulty is likely to arise in this way. A.

523.877

8880. Methods for the quantitative analysis of the atmospheres of stars pertaining to the first spectral types. G. Godoli. *Ricerca sci.*, **24**, 799–813 (*April*, 1954) *In Italian.*

These are explained and discussed to prove how the parameters characterizing stellar atmospheres can be obtained from the experimental data. A.

523.877

8881. The transfer of radiation by an emitting atmosphere. III. H. G. Horak. *Astrophys. J.*, **119**, 640–6 (*May*, 1954).

For Pt II, see Abstr. 5244 (1954). The transfer of radiation by a plane-parallel atmosphere containing a uniform distribution of emission sources is considered for the following cases: (*a*) scattering according to the Rayleigh phase function and (*b*) Rayleigh scattering. The exact expressions for the emergent intensity are derived for finite atmospheres. The solutions in the nth approximation for any depth τ are also given. Polarization calculations are made for an atmosphere of optical thickness $\tau_1 = 0{\cdot}20$. A.

523.877

8882. A study of the atmospheres of early *O* and *Of* stars. J. B. Oke. *Astrophys. J.*, **120**, 22–40 (*July*, 1954).

Spectrograms with a dispersion of 10·2 Å/mm and covering the range from λ3300 to λ4900 have been obtained for eight early *O* and *Of* stars. Equivalent widths of nearly all measurable absorption lines have been obtained and are listed and analysed. The very small effective gravity g_g, as measured by the gas pressure, is a result primarily of the large radiation pressure which nearly counterbalances gravity. Approximate values are obtained for the mass, luminosity and radius of an *Of* star, which are in fairly good agreement with the observational evidence. The small value of $\log n_e$ does leave, however, a possible discrepancy in the breadths of the weaker hydrogen and helium lines, in the sense that the observed lines are too wide. This discrepancy is removed if the density of the atmosphere is increased by a factor of about 3. The emission lines of N III at λ4634 and λ4640 and the He II line at λ4686 have also been studied. Typical profiles are shown. It is shown that the emission-line intensities are almost certainly varying in a few hours in the two stars for which adequate data are available. The proposal is made that the emission lines arise in the upper atmosphere of the stars rather than in an extended shell. Three circumstances suggest this: (1) the profiles of the emission and absorption lines are very similar in shape and breadth; (2) in one star, which is rotating rapidly, the emission lines show roughly the same rotational velocity as do the absorption lines; (3) the ratio of the emission equivalent widths of λ4640 and λ4634 indicates considerable self-absorption, which would not be expected for dilution factors much less than unity. A.

523.877 : 521.042

8883. The relative abundance of hydrogen to helium in stars. A. B. Underhill. *J. Roy. Astron. Soc. Canada*, **47**, 153–9 (*July–Aug.*, 1953).

The determination of the relative abundance of hydrogen to helium in astronomical objects is reviewed and some recent results are collected. It is shown that both the study of the stellar interior and the study of stellar atmospheres suggest that the number of helium atoms in the stars is about 4–5% of the number of hydrogen atoms. A.

525.3 : 550.38

Rock magnetism and Polar wandering. *See Abstr.* 9795

525.35

8884. Effect of the melting of polar ice on the length of the day. S. A. Korff. Letter in *Phys. Rev.*, **95**, 296–7 (*July* 1, 1954).

The melting of polar ice is able to explain quantitatively both the regular periodic and the irregular fluctuations of considerable amplitude in the rotation of the earth. Numerically, the moment of inertia I of the earth is taken as $8{\cdot}1\times10^{44}$ g.cm^2, its angular velocity ω as $8{\cdot}64\times10^4$ sec/day and the moment of inertia of one cubic km of ice in the polar region as about 10^{31} g.cm^2. Then the approximate equation $dI/I = -d\omega/\omega$ (where dI is the resulting change in the moment of inertia, and $d\omega$ that in the rotational speed) demands a change in dI/I of 3×10^{-13} if the ice melts. If the entire surface of the Greenland icecap (amounting to about 10^7 cubic km) lowers by as little as 10 cm, the corresponding change would be $d\omega/\omega = 3\times10^{-10}$ or about 26 μsec per day. Geological evidence in the form of glacially eroded formations established a lowering of at least this, or even three times this size. In Antarctica, the results of a recent expedition (G. de Q. Robin, 1953) point to an ice-area of some 15 million km^2 and 2 km thickness, so that a lowering of the ice level of only 3 cm would here suffice to produce the same 26 μsec per day change in the rotational period. The observed breaking-off and melting of huge tabular icebergs, together with the fact that the seasons are out of phase (so that the accumulations of ice in the north coincide with the melting in the south), should thus lead to a 6-monthly periodicity. The general recession of glaciers will give rise to a long-time progressive change superposed on semi-annual fluctuations. Only one or two tenths of a per cent of all the earth's ice need melt to cause a one-second-per-year change in the length of the day. A. BEER

529.786

8885. Atomic clocks and frequency standard on an ammonia line. I. K. Shimoda. *J. Phys. Soc. Japan*, **9**, 378–86 (*May–June*, 1954).

Various causes of errors in an atomic clock utilizing the 3–3 line of ammonia are examined theoretically and experimentally. A brief description of a Stark modulation atomic clock designed for experimental purposes is given. It is shown that the fractional error will exceed 1 part in 10^{-8}, unless high degree of frequency-insensitive multipler output and excellent matching of waveguide to generator and detector are achieved. A.

PHYSICS 53

FUNDAMENTALS 530.1

530.1

8886. Eddington's theory in terms of the concept of order. E. W. Bastin and C. W. Kilmister. *Proc. Camb. Phil. Soc.*, **50**, *Pt* 3, 439–48 (1954).

The concepts of order and of theory-languages [Abstr. 4147 (1954)] are used in an attempt to clarify certain underlying ideas in the development of Eddington's Fundamental Theory. The relation between the *E*-frame and the theory-language S^2 is discussed in detail. The statistical theory is related to S^4. R. A. NEWING

530.1

8887. Statistical concepts in theoretical physics. R. Fürth. *Brit. J. appl. Phys.*, **5**, 273–6 (*Aug.*, 1954).

The introduction of the principle of statistical physics into the curricula of students of physics at an early state is advocated, and the need for explaining the apparent incompatibility of the concepts of causation and chance is emphasized. First the meaning of causal laws in physics is briefly discussed, and it is shown that it is not possible to prove the law of causation by experimental verification. Then the meaning of statistical laws is explained, and it is pointed out that they constitute true laws of nature which cannot be deduced by mere speculation. The opinion is expressed that statistical physics should be taught on an empirical basis rather than on the basis of "*a-priori* probability," the concept of which is critically examined. The conceptual difficulty, inherent in the kinetic theories, of reconciling the existence of macroscopic statistical laws with the presumed causal nature of the microscopic processes is pointed out, and it is indicated how this difficulty can be overcome by introducing the more general notion of "stochastic laws," the mathematical formalism of which is compared with that of the causal laws of classical physics. The establishment of stationary distributions and the meaning of *a-priori* probability are discussed from this point of view. Finally, it is suggested that the transition from classical to quantum physics can be made much easier for the students if they are first taught classical statistical physics in the indicated manner, as the laws of quantum mechanics can also be interpreted as stochastic laws. A.

530.12

8888. Radiation absorbing systems. P. C. Vaidya. *Proc. Nat. Acad. Sci. India A*, **20**, *Pt V*, 193–204 (1951).

A gravitational situation where a sink of radiation develops at a point of the homogeneous non-static universe of general relativity is studied in detail. This study shows that Einstein's field equations do allow solutions which can be interpreted as describing the gravitational field of a new type of distribution of matter absorbing radiation from the surrounding cosmos. Apart from the fact that a new gravitational situation is discussed there is an intrinsic interest in the new spherically symmetrical non-static solution of Einstein's equations obtained here. A.

530.12

8889. An interpretation of the field tensor in the unified field theory. N. W. Taylor. *Austral. J. Phys.*, **7**, 1–4 (*March*, 1954).

It is assumed that the skew symmetric part of the field tensor g_{ik} is a complex, self-dual tensor. This permits the whole set of field equations for free space to be derived directly from the theory without the introduction of an electric current density tensor. However, with this assumption it appears impossible for spherically symmetric electric and magnetic fields to exist in free space. A.

530.12

8890. Critical observations on new solutions of the clock paradox. M. Galli. *R.C. Accad. Naz. Lincei*, **16**, 356–63 (*March*, 1954) *In Italian.*

530.12 : 538.3

The singular electromagnetic field. *See Abstr.* 9395

530.145

8891. On a theory due to I. Fényes. A. F. Nicholson. *Austral. J. Phys.*, **7**, 14–21 (*March*, 1954).

Fényes [Abstr. 5523 (1952)] has attempted to base quantum mechanics on a theory of Markoff processes in the configuration space of any system considered. It is shown here that for certain systems the allowable stationary-state solutions of the basic equations of this theory are more numerous than the stationary states predicted by quantum mechanics through the Schrödinger equation, and that it is not possible to identify the probability amplitude defined in this theory with the Schrödinger wave-function. It is pointed out that the "total stochastic velocity" of a particle in this theory cannot equal the linear momentum divided by the mass, that Fényes' uncertainty relation is not equivalent to the Heisenberg relation, and that the total-stochastic-velocity operator has properties different from those of the quantum-mechanical momentum operator. It is shown that Fényes' proof that the addition of further parameters to a set of statistical parameters cannot lead to a set affording a causal description of the motion of a system is unsatisfactory, but that this conclusion may reasonably be drawn from his theory, by making a consistent auxiliary assumption. A.

530.145

8892. Cauchy problems in quantum theory of fields. A. Deprit. *Ann. Soc. Sci. Bruxelles I*, **68**, *No.* 1–2, 119–32 (1954) *In French.*

The Green function treatment, which R. P. Feynman proposed in order to solve the Schrödinger equation, is rigorously justified by a distribution treatment. The "total transition amplitude" appears to be the "elementary kernel" of this equation. A.

530.145

8893. On the solution of the equations of field theory. II. G. Rideau. *C.R. Acad. Sci.* [*Paris*] **238**, 2227–30 (*June* 9, 1954) *In French.*

Using the results of a previous note [Abstr. 8029 (1954)] an integral equation is derived for a bound-

state wave-function, the terms of the kernel being the successive potentials of the Levy method.

P. T. MATTHEWS

530.145

8894. Integral equations of quantized field theory. H. S. GREEN. *Phys. Rev.*, **95**, 548–56 (*July* 15, 1954).

A systematic method is developed for the solution of the integral equations of quantized field theory. It is first shown how to generalize these equations for any number of fermions in interaction with a boson field, and then how to apply the renormalization procedure to the resulting equations. A method of approximation to the solution of the "renormalized" equations is described, which yields divergence-free covariant scattering amplitudes, analogous to the Tamm–Dancoff amplitudes. It is shown that the nth order Tamm–Dancoff amplitudes do not approach limiting values for large n, and that the procedure does not therefore converge; but that a somewhat modified procedure would probably do so. Singularities in the scattering amplitudes, regarded as functions of the coupling constant, are related to the existence of bound states. A.

530.145

8895. Canonical transformation for an electron-positron field coupled to a time-independent electromagnetic field. II. H. E. MOSES. *Phys. Rev.*, **95**, 237–42 (*July* 1, 1954).

For Pt I, see Abstr. 2189 (1953). A prescription for constructing well-defined field operators from a single-particle operator is given in a form in which electrons and positrons appear in a symmetric way. Such a prescription removes certain trival infinities arising from the conventional "hole" theory approach. The canonical transformation derived in Pt I is used to calculate the vacuum expectation values of various operators to the second order in electron charge. It is shown that, despite the fact that the scattering operator does not exist when the electromagnetic field is constant in time, one obtains the usual results for current and charge densities. In addition, the striking result is proved that for certain purely electrostatic fields the expectation values of the number operator are finite but that when a magnetostatic field is also present the expectation values are infinite. A.

530.145

8896. Two-body system in quantum electrodynamics. Energy levels of positronium. T. FULTON AND P. C. MARTIN. *Phys. Rev.*, **95**, 811–22 (*Aug.* 1, 1954).

Expressions are obtained for all $\alpha^3 Ry$ contributions to the energy levels of the two-fermion system in electrodynamics. These expressions are evaluated from a relativistic two-body equation which takes binding into account in its interaction operator. They are specifically calculated for the $n = 2$ levels of the system. Corrections arise from three sources: (1) improved treatment of pair effects of the Coulomb field and of the exchange of transverse photons, (2) self-energy and vacuum polarization terms, and, in positronium, (3) second-order annihilation processes. The energy shifts resulting from (1) and (2) do not depend on the arbitrary masses through a single parameter like reduced mass. In the limit appropriate to hydrogen, the previously calculated two-body corrections of item (1) are confirmed. The principal new result is the determination of the $n = 2$ levels of positronium. In contrast to hydrogen, where the self-energy effect is dominant, here all three items yield roughly equal corrections. Together, they amount to about 3% of the $\alpha^2 Ry$ level splitting. A.

530.145 : 538.3

8897. The integration of Maxwell's and Lorentz's equations by operational methods. R. REULOS. *C.R. Acad. Sci.* [*Paris*] **238**, 2225–7 (*June* 9, 1954) *In French.*

Some formal solutions of the electromagnetic field equations are obtained using operational methods. These solutions are specially adapted to the study of the fields associated with moving particles.

A. T. PRICE

530.145 : 538.3

Solution of the Maxwell and Dirac equations for given initial conditions. *See Abstr.* 9396

530.145

8898. The equations of motion of the electron. J. I. HORVÁTH. Note in *Acta phys. Hungar.*, **3**, *No.* 3–4, 171–204 (1954) *In German.*

The electron is treated classically and relativistically. A tensor is formed to take account of the spin (and the velocity-dependent electric dipole) of the electron. The Langrangian and equations of motion are obtained and the Riesz method and potential are employed. The Lienard–Wiechert potential and the potential arising from the magnetic moment of the electron are obtained. The calculation of the self-force is discussed briefly. G. E. BROWN

530.145

8899. On the Green-functions of many-electron problem. S. NAKAI. *Progr. theor. Phys.*, **11**, 155–78 (*Feb.*, 1954).

The Dirac-field Green functions for many-body problems are derived with their fundamental equations from the standpoint of the S-matrix theory. Further, the possibility of removing divergences contained in them together with those contained in the quantities of one-body problems is demonstrated by a consistent use of the concepts of mass and charge renormalization. For the latter it is assumed that the convergence of the perturbation series currently in use after renormalization has been carried out. As the argument is, therefore, essentially based upon the assumption of expandability in powers of the coupling constant, it runs counter to Schwinger's intention. However, the physical meaning of several quantities is understood more easily. A.

530.145

8900. On the representation of particles in uniform rectilinear motion by waves with localized singularities moving along the trajectories. G. PETIAU. *C.R. Acad. Sci.* [*Paris*] **238**, 1973–5 (*May* 17, 1954) *In French.*

The Klein–Gordon equation is discussed from this point of view. P. T. MATTHEWS

530.145

8901. Time-dependent variational principle. S. ALTSHULER AND J. F. CARLSON. *Phys. Rev.*, **95**, 546–8 (*July* 15, 1954).

A variational principle for the transition amplitude

is derived for interactions which are explicitly time-dependent. The form is similar to the Schwinger variational principle for the transition amplitude in stationary-state collision theory. A.

530.145

8902. Decomposition of the scalar product of two symmetric tensors. M. H. COHEN. *Phys. Rev.*, **95**, 674–5 (*Aug.* 1, 1954).

A simple method is given for the decomposition of the scalar product of two symmetric tensors into products of their irreducible components, which leads also to an explicit recipe for a set of irreducible components of a symmetric tensor. Applications to dipole-dipole interaction and electrostatic multipole interaction are discussed. A.

530.145

8903. Phenomenological many-body exchange forces. L. E. H. TRAINOR. *Phys. Rev.*, **95**, 801–10 (*Aug.* 1, 1954).

Phenomenological many-body exchange potentials are defined in group-theoretical analogy with the usual 2-body exchange potentials of Heisenberg, Bartlett and Majorana. The uniform model of Wigner is then extended to include many-body Wigner and Majorana forces. The theory predicts a symmetry energy between neighbouring isobars of even-odd nuclei which depends upon whether the isobar of highest T_ζ is *OE* or *EO*, where *OE* signifies that the odd number of particles is greater than the even number, and *EO* signifies the reverse. A comparison is made with such energy differences in $T_\zeta = \frac{3}{2}$ and $\frac{1}{2}$ isobars, taken from β-decay data in the range $15 \leqslant A \leqslant 59$. This leads to a rough estimate of the magnitude and sign of the contribution from 3-body potentials. On this basis, the contribution from 3-body potentials is not negligible in comparison with that from 2-body potentials. A.

530.145

8904. Effects of certain three-body nuclear interactions in H^3 and He^3. A. W. SOLBRIG, JR. *Phys. Rev.*, **95**, 831–6 (*Aug.* 1, 1954).

This limited, theoretical study is phenomenological and non-relativistic. Effects of interactions on wave functions, magnetic dipole moments and binding energies are obtained by first-order perturbation methods. The interactions satisfy well-known requirements of invariance, contain no power of momentum higher than the first, involve no dependence on charge and introduce only *P* state in a first-order calculation. They contain spin-orbit interactions and may give rise to interaction moments. Each interaction contains a scalar radial function of positions *f*. The unperturbed potential corresponds to pairwise Hooke's law forces between nucleons. The first-order energy perturbation is shown to vanish for all the interactions. It is shown, without further specialization of the *f*, that no one of fifty-eight of the seventy-five interactions yields observed magnetic moments. No definite conclusion is obtained for eleven of the remaining seventeen interactions, for calculations with plausible *f* appear difficult. Each of the remaining six interactions yields observed magnetic moments with plausible *f*. A.

530.145

8905. Bound states and *S*-matrix in quantum field theory. S. NAKA. *Progr. theor. Phys.*, **11**, 179–89 (*Feb.*, 1954).

The relationship between bound states and steady states defined by Dyson is investigated following Hamilton's treatment. A different *S*-matrix expression from that of Hamilton is obtained, however, when the relevant terms of the *S*-matrix for the two-body scattering are resolved into the infinite series. So from the author's standpoint, a homogeneous integral equation describing bound states is derived keeping close connection with Møller's *S*-matrix theory. A.

530.145

8906. Definitions and analytical properties of the *R* and *S* matrices associated with tensor forces. I. Case of the *R*-matrix. W. LASKAR AND M. MOSHINSKY. *C.R. Acad. Sci.* [*Paris*] **238**, 2496–8 (*June* 28, 1954) *In French.*

This deals with the construction of the *R*-matrix of Wigner and Eisenbud. G. E. BROWN

530.145

8907. Definitions and analytical properties of the *R* and *S* matrices associated with tensor forces. II. Case of the *S*-matrix. W. LASKAR AND M. MOSHINSKY. *C.R. Acad. Sci.* [*Paris*] **239**, 29–31 (*July* 5, 1954) *In French.*

It is shown that the *S*-matrix is a meromorphic function of the wave number k and has no poles in the upper half of the k plane, except, possibly, on the imaginary axis. G. E. BROWN

530.145

8908. The formal theory of error estimation of rearrangement collisions. T. SASAKAWA. Letter in *Progr. theor. Phys.*, **11**, 121–3 (*Jan.*, 1954).

Using the impulse approximation, generalized to include multiple scattering effects, it is shown how the error of a rearrangement collision can be expressed as the sum of the separate errors associated with the entrance channel, the outgoing channel and the wave-function used. P. T. MATTHEWS

530.145

8909. Nucleon isobars and nuclear forces in low energy region. T. KIKUTA. Letter in *Progr. theor. Phys.*, **11**, 118–20 (*Jan.*, 1954).

The Pauli–Kusaka potential is used to estimate the probability amplitudes, effective potentials and other effects of isobaric states. G. E. BROWN

530.145

8910. Nonlinear meson theory of nuclear forces. F. CAP. Letter in *Phys. Rev.*, **95**, 287–8 (*July* 1, 1954).

A Lagrangian of the form $\alpha^{-1}[(1 - \alpha\phi)^{\frac{1}{2}} - 1]$ is proposed, where α is a constant such that the total meson field energy is equal to the self-energy of the nucleon and ϕ is the Lagrangian in neutral linear scalar meson theory. This gives rise to a static spherically symmetric potential $A(r)$ which is finite at $r = 0$ and with $A'(0) = 0$. Application to the deuteron case, in classical approximation, is discussed. G. FIELD

530.145

8911. A meson effect in the dipole selection-rule in selfconjugate nuclei. G. MORPURGO. *Nuovo Cimento*, **12**, 60–80 (*July*, 1954).

An effect is pointed out by which a well-known selection rule for emission of dipole radiation in a transition between two levels having the same charge-parity (or isotopic spin) in self-conjugate nuclei may be weakened. The effect depends on the fact that the total momentum of the nucleons plus the momentum associated with the fluctuations of the mesonic field in a nucleus is a constant of the motion but not the total momentum of the nucleons only; while this last circumstance is assumed in the usual derivation of the above selection rule. The factor of weakening has been calculated and turns out to be of the order (in amplitude) $(g^2/4\pi)(\mu/Mc^2) \simeq U/Mc^2$ where U is some average potential energy in the nucleus, M the mass of a nucleon and μ the inverse Compton wavelength of a meson. This is the same order of magnitude as the one due to Coulomb impurity. If it be possible with an increasing experimental accuracy to separate at least for some transition the mesonic effect from the Coulomb one, this would furnish a direct experimental proof for the existence of virtual mesons in a nucleus or, in other words, for a relativistic (meson) theory of nuclear forces. A.

530.145

8912. Meson production in meson-nucleon collisions. B. D'ESPAGNAT. *K. Danske Vidensk. Selsk., mat.-fys. Medd.*, **28**, *Paper* 11, 48 *pp.* (1954).

The production of one meson in meson-nucleon collisions is investigated, with the purpose of expressing the differential and total cross-section for the process in terms of the known parameters of elastic meson-nucleon scattering. As little use as possible is made of the questionable approximations of field theory. Particular attention is paid to the reaction in which two positive mesons emerge. A comparison is made with nuclear reactions. Although the two processes are very different, such a comparison still makes it likely that the l, J contribution to meson production (l, relative orbital, J, total angular momentum) is in some rough way proportional to the l, J contribution to elastic scattering. The same conclusion is reached independently through a field theoretical approach; it is therefore believed to be true, although neither of the two methods is entirely cogent by itself. Formulae are derived for the total cross-section for production and the angular distribution of the emergent mesons. The first is considered to give only an order of magnitude, and agrees roughly with what a purely statistical approach to the problem would give. The angular distribution result is further supported by an argument of invariance under rotation of the co-ordinate system and is therefore considered to have good reliability as long as the l, J expansion remains workable. A.

530.145

8913. Note on meson-nucleon interaction. S. MINAMI. Letter in *Progr. theor. Phys.*, **11**, 123–4 (*Jan.*); Erratum, 230 (*Feb.*, 1954).

The possibility is examined that the $\frac{3}{2}, \frac{3}{2}$ resonance in meson-nucleon scattering is predominantly a d-wave effect. P. T. MATTHEWS

530.145

8914. An invariance theorem for cross sections of meson-nucleon scattering. S. MINAMI. *Progr. theor. Phys.*, **11**, 213–18 (*Feb.*, 1954).

Certain points must be borne in mind in attempting to determine the values of phase shifts from experimental data for meson-nucleon scattering. Even if an exact knowledge could be obtained of the differential cross-section for this process, and high orbital angular momenta of meson taken into account, it will be found that two equally possible sets of solutions are in existence as phase shift. This ambiguity is of a fundamental character, has its origin in certain properties of the spherical harmonics and of the spin function and apparently remains unnoticed in the numerical analysis of Fermi and Yang. A.

530.145

8915. Riesz potential and the elimination of divergences from meson theory. L. S. KOTHARI. *Proc. Phys. Soc.* [*London*] *A*, **67**, 580–5 (*July*, 1954).

Using a modified definition of Riesz potential for the neutral vector meson field, the potential on the world line of a nucleon is calculated. The "lower order" meson potential corresponding to $\alpha = -2$ is given. Finally the self-energy of a nucleon in direct interaction with neutral vector mesons as well as with pseudoscalar mesons is evaluated. A finite expression is obtained without having to introduce any cut-off factors or auxiliary fields. A.

530.145

8916. A covariant non-adiabatic equation for nucleon-pion scattering. J. C. TAYLOR. Letter in *Nuovo Cimento*, **12**, 148–9 (*July*, 1954).

A method of approximate solution for the $j = \frac{1}{2}$, $T = \frac{1}{2}$ scattering has been suggested by Fubini [Abstr. 1046 (1954)] and others. The appropriate renormalization procedure, consistent with that of Dyson, is given in this note. P. T. MATTHEWS

530.145

8917. Covariant approximation scheme for Green's functions of coupled fields. R. ARNOWITT AND S. GASIOROWICZ. *Phys. Rev.*, **95**, 538–45 (*July* 15, 1954).

The scattering and production Green's functions for one nucleon and an arbitrary number of mesons are related by an infinite set of coupled linear integral equations. The first N of these equations contain Green's functions involving 0, 1, 2, . . . N external meson lines. The set of equations may be cut off at any point by making an assumption as to the structure of the Green's function with the highest number of external meson lines. In particular this function is approximated by decomposing it into products of lower-order Green's functions, the physical assumption being that one of the mesons interacts weakly with the remaining meson-nucleon system. This leads to a closed set of equations which are linear if vacuum polarization is neglected. Examples of successive approximations are derived. The formalism is also applied to the two-nucleon case and to the three-fields problem, the latter being treated in a manifestly gauge-covariant manner. A.

530.145

8918. A method for the solution of nuclear bound-state problems. I. E. McCarthy and H. S. Green. *Proc. Phys. Soc.* [*London*] *A*, **67**, 719–25 (*Aug.*, 1954).

It is shown that the Fredholm method for the solution of integral equations can be adapted to solve the covariant scattering equations for the proton-neutron system and the meson-nucleon system. A practical method is devised for obtaining the binding energies of the deuteron and hyperon in a fully covariant way. As a test of the method it has been applied to the corresponding non-covariant equation for the deuteron, and satisfactory numerical results are obtained. A.

530.145

8919. Analysis of the structure of transformation function in quantum mechanics. S. Tani. *Progr. theor. Phys.*, **11**, 190–206 (*Feb.*, 1954).

A new device in operator calculus is introduced to treat expressions which contain non-commutable factors. By means of this technique the defining equation for the generator of transformation function of exponential type is derived. It is shown that this equation contains exclusively commutators of relevant quantities. Then, making use of this peculiarity of the exponential formula, a method is proposed for analysing the structure of the transformation function out of a given Hamiltonian of the system, and this is explained by some examples. This method consists of the following procedures: first, decomposition of the given Hamiltonian into parts of different character and abstraction of elementary matrices from it; second, formation of commutators between these matrices and extension, if necessary, of the set of matrices enumerated at the beginning to include new ones which appear through the operation of commutation. The matrix ring thus obtained constitutes the framework of the transformation function. A.

530.145

8920. A numerical solution of Schrödinger's equation in the continuum. W. Futterman, E. Osborne and D. S. Saxon. *J. Res. Nat. Bur. Stand.*, **52**, 259–64 (*May*, 1954).

Continuum solutions of Schrödinger's equation for two particles that interact according to a central Yukawa potential are obtained by numerical integration. The resulting wave-functions are tabulated, as are the phase shifts which determine the asymptotic behaviour of the solutions. A.

530.145

8921. Remarks on the solution of the Schrödinger equation by a variational procedure. J. I. Horváth. Note in *Acta phys. Hungar.*, **3**, *No.* 3–4, 323–7 (1954) *In German.*

The deviations of the eigenfunctions obtained in atomic problems from the true eigenfunctions are discussed. Since the true functions are not known, Hartree–Fock functions must be used in their place in this comparison. The deviation of the potential occurring in the equation for the variational function from the true atomic potential, as a function of r, can also be used as a criterion for the deviation of the eigenfunctions. G. E. Brown

530.145

8922. Eigenvalues and interaction energy (sequel). E. Schatzman. *Cahiers de Phys.*, *No.* 49, 61–4 (1954) *In French.*

See Abstr. 1435 (1948). It is shown that the energy of interaction (i.e. potential function) is not completely determined by a system of eigenvalues, but that a potential can be modified in an infinity of different ways without the eigenvalues being altered. In order to determine a microscopic field it is also necessary to know the transition probabilities between the levels. A. J. Taylor

530.145

8923. Validity of the Born-Oppenheimer approximation. S. Bludman and P. B. Daitch. *Phys. Rev.*, **95**, 823–30 (*Aug.* 1, 1954).

Solutions of the Schrödinger equation for several simple models in which a light particle, mass m, is bound to a heavy particle, mass M, which in turn is bound to another heavy particle which may be fixed are considered as expansions in the parameter $1/\beta \equiv (m/M)^{\frac{1}{2}}$. A characteristic of such systems is that when the light particle is far from the heavy particle, it centres on the mean position of the heavy particle and when it is close to the heavy particle, it centres on the heavy particle. The classical prediction that the change in centring takes place when the motional frequencies of the light and heavy particles are equal is borne out in quantum mechanics except that here the transition takes place over an extended region as shown by the detailed investigation of models. General arguments are presented which show how low and high momenta of the light particle contribute, respectively, to centring on the mean position and on the changing position of the heavy particle. The effect of the centring on expectation values of quantities dependent on the density of the light particle at the heavy one is of the order of the ratio of an average radius of the heavy particle motion to an average radius of the light particle motion. Further corrections due to incomplete centring are of the order $1/\beta$ times this ratio. A.

530.145

8924. On the hydrodynamical model of the quantum mechanics. M. Schönberg. *Nuovo Cimento*, **12**, 103–33 (*July*, 1954).

A new hydrodynamical model for the Schrödinger equation is discussed. The new model differs from that of Madelung by the existence of turbulence. It follows directly from the ordinary interpretation of quantum mechanics, by the introduction of operators for the charge and current densities and the components of the stress tensor in the one-particle formalism. The model is developed for any values of the spin. The Madelung fluid corresponds to the mean motion of the special turbulent medium. The quantum potential appears as a combination of a pressure with terms arising from the turbulence. It is shown that the quantization of the motion of the Madelung fluid introduces the right kind of turbulence. The trajectories of the de Broglie–Bohm theory appear as trajectories of the mean motion of the turbulent medium. A.

530.145

8925. On the relation between quantum hydrodynamics and conventional quantum field theory. F. A. KAEMPFFER. *Canad. J. Phys.* **32,** 530–7 (*Aug.*, 1954).

The conditions are examined under which the procedure of quantum hydrodynamics would be a consequence of the conventional quantization procedure, and vice versa. Using the classical non-relativistic theory of a charged medium as an example, it is shown that the commutation rules of the two procedures differ by a factor 2, if in accordance with an idea by Geilikman the wave function of the classical theory is expanded as $\psi = \psi_0 + \psi_1$, with ψ_0 a constant and $\psi_1 \ll \psi_0$, and if terms of higher than second-order in ψ_1 are neglected in the hydrodynamical description of the theory. A.

530.145

8926. Waves and particles. F. BOPP. *Optik*, **11,** *No.* 6, 255–69 (1954) *In German.*

The various wave and particle interpretations of quantum theory are discussed, and a new interpretation, of the second type, is outlined. [See also abstract following.] P. M. DAVIDSON

530.145

8927. On the nature of waves. F. BOPP. *Z. angew. Phys.*, **6,** 235–9 (*May*, 1954) *In German.*

Quantum mechanical wave theory is discussed in relation to other types of wave motion and some new ideas on its interpretation are outlined. [See also preceding abstract.] P. M. DAVIDSON

530.145

8928. Description of shutter diffraction by a distribution of sources. M. MOSHINSKY. *C.R. Acad. Sci.* [*Paris*] **238,** 2395–7 (*June* 21, 1954) *In French.*

The case of a beam of particles incident on a perfectly reflecting screen is discussed. At a given time the screen is suddenly removed. The diffraction can be described by a plane source, which begins to emit at the time the screen is removed, and which is situated where the screen was before it was removed. G. E. BROWN

530.145

8929. Mass spectrum of elementary particles. I. Eigenvalue problem in space-time. H. ENATSU. *Progr. theor. Phys.*, **11,** 125–42 (*Feb.*, 1954).

In order to avoid the divergent self-energies of quantum field theory and at the same time to get the mass spectrum of elementary particles, a new method is discussed. A generalized wave equation which contains a function of a time-like parameter and four variables in the space-like domain, is assumed. In the wave equation the self-energy of a particle is considered to be a self-potential which is dependent only on the space-like variables. An investigation is made of how the eigenvalue problem for the masses of elementary particles is set up, and is solved by assuming a simple potential form. It is shown that a discrete mass spectrum is obtained for a negative self-potential under some approximations. A.

530.145

8930. Regular and irregular Coulomb wave functions expressed in terms of Bessel–Clifford functions. M. ABRAMOWITZ. *J. Math. Phys.*, **33,** 111–16 (*April*, 1954).

The expressions are derived. The aim is to produce results suitable for computation. Where the expressions are not suitable an alternative technique is given. The computations are to be carried out on the SEAC machine. The Coulomb wave functions are the solutions of the equation $d^2y/dx^2 + \{1 - 2\eta/x - L(L+1)/x^2\}y = 0$, where L is a positive integer and η is a continuous parameter. L. S. GODDARD

530.145

8931. On Born's approximation and its connection with covariant perturbation theory. S. N. BISWAS. *Indian J. Phys.*, **28,** 119–28 (*March*, 1954).

A connection between the usual perturbation method and the covariant perturbation theory of Feynman and Dyson is established by considering the scattering of fast electrons in a static field. It is shown that by the usual perturbation method, the second Born approximation for the scattering of Dirac electrons by the Coulomb potential gives the same result as obtained by Dalitz using the covariant S-matrix of Feynman and Dyson. It also agrees with the expression given by McKinley and Feshbach from the complete solution of Mott. A.

530.145

8932. A note on the divergence of the perturbation method in field theory. S. F. EDWARDS. *Phil. Mag.*, **45,** 758–61 (*July*, 1954).

After certain approximations are made, the divergence of the perturbation series expressing the radiative corrections to the motion of a nucleon, is related to the divergence of the Born approximation to the motion of a bare nucleon in a given field. A.

530.145

8933. An extended use of perturbation theory. R. N. GOULD AND A. CUNLIFFE. *Phil. Mag.*, **45,** 818–22 (*Aug.*, 1954).

It is shown that the unique solution of a partial differential equation $(H + U)\phi = 0$, (1) can be determined in terms of the unique solution of the partial differential equation $H\theta = 0$, (2) and the eigenfunctions of the equation $(H\psi = \lambda\psi$ (3). In (1), (2) and (3), ϕ, θ and ψ denote functions of one or more variables, H and U are operators, and λ is an eigen-value. The equations are to be satisfied throughout a volume D bounded by a surface S which is the same for all three equations. (1) and (2) are subject to precisely the same boundary conditions, ϕ and θ being specified at every point of S and being identical with each other over S. (3) is subject to the boundary condition $\psi = 0$ at all points of S, and the solutions ψ_i are assumed to form a complete set. By reference to the one-dimensional case it is shown that the use of eqn. (3) is not always necessary. Thus, in the particular case where ϕ is a function of one variable x, only, $H = (d^2/dx^2) +$ a constant, and $U = f(x)$, the solution can be derived from equations which can be integrated directly. A.

530.145 : 532.51 : 536.48

A quantum theory for non-viscous fluids in the Lagrange variables. *See Abstr.* 9194

530.162

8934. Information theoretical analysis as a tool in linguistic research. G. HERDAN. *Naturwissenschaften*, **41**, *No.* 13, 293–5 (1954) *In German.*

The author deals with the distribution of spondees and dactyls in Latin poetry. The known combinations and permutations cannot be explained by analysis of variance. However, when information theory is applied, the entropy of the combinations is found to be half as great as the entropy of the permutations. This is interpreted to signify that chance and word structure are about equal in the Latin hexameter.

T. J. REY

530.162

8935. On Bose–Einstein functions. J. CLUNIE. *Proc. Phys. Soc.* [*London*] *A*, **67**, 632–6 (*July*, 1954).

Asymptotic expansions are found for the integral $G_k(\eta)$ defined by

$$\int_0^\infty \frac{x^k dx}{\exp(x-\eta)-1} \text{ if } \eta \leqslant 0,$$

and as the Cauchy principal part of the same integral if $\eta > 0$. A table is constructed for $k = \frac{1}{2}$, and the ranges $-3 \leqslant \eta \leqslant -0{\cdot}6(0{\cdot}2)$, $-0{\cdot}5 \leqslant \eta \leqslant 0{\cdot}5(0{\cdot}1)$, $0{\cdot}6 \leqslant \eta \leqslant 20(0{\cdot}2)$. A.

530.162 : 536.7

8936. On the theory of reciprocal relations between irreversible processes. Statistical foundations of thermodynamical fluctuation theory in moving media. J. VLIEGER AND S. R. DE GROOT. *Physica*, **20**, 372–82 (*July*, 1954).

De Groot and Mazur [Abstr. 6308 (1954)] have extended Onsager's proof of reciprocal relations between irreversible processes to the case of vectorial and tensorial phenomena. In the derivation expressions are used for certain averages of fluctuations of the variables α_i^μ and β_k^μ, which describe the state of a great number of cells μ, into which the system is divided. These averages are calculated with the help of the probability distribution $P \sim \exp\{\Delta S(\alpha_i^\mu, \beta_k^\mu)/k\}$, (1), where ΔS is the derivation of the entropy from its equilibrium value. The use of formula (1) in the case, where the state variables include barycentric velocities of the material elements, should be justified. This is possible, but in the present paper a slightly simpler method is preferred to find the averages of the fluctuations, necessary for the proof of reciprocal relations. It turns out, that for their derivation distribution functions for the state variables of one or two cells suffice. From statistical calculations these are found to be $P_1 \sim \exp(\Delta S_1^0/k)$, (2), $P_{12} \sim \exp\{(\Delta S_1^0 + \Delta S_2^0)/k\}$, (3), where ΔS_i^0 is a quadratic form in the state variables of the cell i (= 1, 2), including barycentric velocities. In the theory independent state variables are used in a natural way, in contrast with De Groot and Mazur's (and Casimir's) treatment, where dependencies exist amongst the state variables as a consequence of the conservation of mass and energy. One could of course eliminate a number of variables, so as to obtain a set of independent state variables, but this complication can be avoided by using the distribution functions (1) and (3) instead of (1), as is done in this paper. A.

530.162 : 536.7

8937. On the statistical mechanics of mixtures. I–II. I. PRIGOGINE AND S. LAFLEUR. *Bull. Acad. Roy. Belgique Cl. Sci.*, **40**, *No.* 5, 484–96, 497–507 (1954) *In French.*

In the first paper the statistical mechanics of a multicomponent system restricted to one dimension and nearest neighbour interactions only is developed. This theory is used in Pt II to study excess free energy, excess energy and excess entropy respectively. The method proves to be equal to that of the cell model for spherical molecules. One result shows excess entropy to be mainly governed by change of vibration frequencies on mixing and also by the volume change.

T. C. TOYE

530.17

8938. Analogy of hydraulic, mechanical, acoustic and electric systems. J. C. SCHÖNFELD. *Appl. sci. Res. B*, **3**, *No.* 6, 417–50 (1954).

A clearer conception of the analogies is pursued by treatment of hydraulic systems as distinct from mechanical systems, interpretation of acoustic as mixed mechanic-hydraulic systems, analysis of the operation of piston mechanisms, and consideration of gyro-elements. A.

GENERAL MECHANICS . MECHANICS OF SOLIDS 531

531.258

8939. A rigid curvilinear polygonal core in an infinite plate under tensions at infinity and shear. B. KARUNES. *Indian J. Phys.*, **28**, 133–40 (*March*, 1954).

The function theoretic method of Muschelisvili for solving two dimensional problems in elasticity is employed to obtain solutions to the problems of a rigid curvilinear polygonal core in an infinite plate under (i) an all-round tension at infinity, (ii) a uniform tension at infinity at an inclination to the x-axis and (iii) a uniform shear in the plane of the plate. A.

531.38

8940. Rectilinear alignment on elastic strips. Comparison of various known and new designs. J. E. PLAINEVAUX. *Nuovo Cimento*, **12**, 37–59 (*July*, 1954) *In French.*

A more general development of work previously reported [Abstr. 3149 (1954)]. The case of a simple strip is considered by developing the Fourier series for its deformation. The vertical contraction of the strips is determined and compensated suspensions both free and constrained are studied. These are intercompared and the advantages of the constrained suspension are shown. The case of suspensions of different length is treated and new methods of suspension are discussed in detail. G. F. HODSMAN

MECHANICAL MEASUREMENTS 531.7

531.717 : 539.165

The β-ray absorption spectrum of $^{147}Pm_{61}$ and its application to thickness measurement. *See Abstr.* 9560

531.752

8941. An analytical balance for recording rapid changes in weight. F. A. MAUER. *Rev. sci. Instrum.*, **25**, 598–602 (*June*, 1954).

An analytical balance has been modified by adding a solenoid and magnet so that changes in weight can be balanced electrically. The operation is made automatic by reflecting a beam of light from the balance beam into a dual phototube in a bridge circuit and amplifying the output of the bridge to provide current in the solenoid. Recording the voltage drop across a resistor in series with the solenoid gives a linear weight scale which can be made to read directly in milligrams. An electronic damping circuit enables the balance to follow very rapid changes in weight without oscillating and with an accuracy better than 0·5% of full scale for ranges of 100 mg and over. A.

531.786

8942. Magnetic measurement of torque in a rotating shaft. R. A. BETH AND W. W. MEEKS. *Rev. sci. Instrum.*, **25**, 603–7 (*June*, 1954).

In a cylindrical shaft under pure torsion the principal stress lines are 45° helices around the axis, one for tension and the other for compression. These are also the directions of maximum and opposite permeability changes for a shaft of magnetostrictive material. Based on these ideas a magnetic torque measuring device has been devised and tested. It consists of an external magnetic yoke carrying a driving coil and pickup coils on each of several branches to detect the permeability changes in flux paths lying in or near the principal stress directions in the shaft. Linear response, good sensitivity and fair stability have been obtained with rotating shafts. A.

MECHANICS OF FLUIDS 532

532.13 : 532.584

8943. The Einstein relation between relative viscosity and volume concentration of suspensions of spheres. A. J. HUGHES; D. R. OLIVER AND S. G. WARD. Letters in *Nature* [*London*], **173**, 1089–90 (June 5, 1954).

Einstein's formula for the relative viscosity, $\eta_r = 1 + 2{\cdot}5\,c$, is actually an expansion of $\eta_r = (1 + \frac{1}{2}c)/(1 - 2c)$. The latter formula is in good agreement with experiments on suspensions of spherical killed yeast for volume concentrations up to 14%. R. O. DAVIES

532.133 : 532.14 : 532.612.4

8944. The density, surface tension and viscosity of deuterium oxide at elevated temperatures. J. R. HEIKS, M. K. BARNETT, L. V. JONES AND E. ORBAN. *J. phys. Chem.*, **58**, 488–91 (*June*, 1954).

The density and viscosity of 99·20% deuterium oxide have been determined from 30 to 250° while surface tension measurements were made from 100 to 216°. A bob suspended from a 200 μ fused quartz fibre spiral inside a pressure vessel was used to determine the densities to the nearest 0·0003 g/cm^3. The ratio of the densities of deuterium oxide to ordinary water increases with temperature up to about 80°, but decreases with still further increases in temperature. A Lawaczeck falling body viscometer, in which the time of fall of a radioactive plummet was measured with the use of coincident counting tubes, showed the viscosity of deuterium oxide to be 21% higher than ordinary water at 30° while at 250° this difference decreased to 9·7%. The height of rise of liquid in a capillary tube showed that the surface tension of deuterium oxide and ordinary water are about the same at 100°, but with increasing temperature the surface tension for deuterium oxide becomes steadily less until at 220° it is about 3% less than the value for ordinary water. A.

532.133 : 534.2

8945. The viscosity of volume. II. A. CARRELLI AND F. CENNAMO. *Nuovo Cimento*, **12**, 1–4 (*July*, 1954) *In Italian.*

For Pt I, see Abstr. 6320 (1954). The second viscosity coefficients were measured for amyl alcohol, benzene and carbon tetrachloride, with tubes of different diameters and at various frequencies using the experimental device described previously. Though absolute values of the second viscosity coefficient are not obtained, it is asserted, as in the case for water, that this coefficient exists also for these three liquids. A.

532.137

8946. A capillary viscometer with continuously varying pressure head. S. H. MARON, I. M. KRIEGER AND A. W. SISKO. *J. appl. Phys.*, **25**, 971–6 (*Aug.*, 1954).

A new capillary viscometer has been designed to study the flow behaviour of non-Newtonian fluids. The instrument is convenient, absolute, and accurate, and covers continuously a wide shearing stress range in a single determination. A falling mercury column forces the sample through the capillary. Measurement of the column height as a function of time gives both pressure drop and flow rate. Provision is also made for the use of driving fluids less dense than mercury for measurements at lower shearing stresses. The density of the sample need not be determined. Methods and illustrations are given of the application of the new instrument to the determination of the absolute viscosities of Newtonian liquids, and the flow curves of non-Newtonian fluids. A.

532.14 : 532.65

8947. Some observations on determining density of fluids by the falling drop method. R. P. A. SIMS. *Canad. J. Chem.*, **32**, 506–11 (*May*, 1954).

The shape of the calibration curve obtained with a commercial falling drop apparatus has been investigated for drops varying in viscosity and surface tension and in media of varying solvent power. Drop velocity affects drop shape when the viscosity of the drop substance is low, and drop volume when the medium exerts solvent action on the drop. "End effect" appears to be significant even when "wall effect" is large. A.

532.51

8948. Hydrodynamical generalized singular points. B. R. SETH. Letter in *Curr. Sci.*, **23**, 184–5 (*June*, 1954).

The author gives examples supporting his contention that the introduction of the idea of generalized singular points simplifies problems in classical hydro-

dynamics, so that most of the results of the linear theory can be easily reproduced. Thus, e.g., the uniform motion of an ellipsoid in a non-viscous liquid can be produced by a single ellipsoid doublet, just as that of a sphere can be produced by a spherical doublet. J. S. G. THOMAS

532.51 : 530.145 : 536.48

A quantum theory for non-viscous fluids in the Lagrange variables. *See Abstr.* 9194

532.51 : 530.162

8949. Statistical hydrodynamics in porous media. A. E. SCHEIDEGGER. *J. appl. Phys.*, **25**, 994–1001 (*Aug.*, 1954).

The statistics of disordered phenomena as exemplified by Einstein's theory of the Brownian motion is applied to the flow of fluids through porous media. It is shown that such a statistical treatment of the hydrodynamics in porous media automatically explains some well-known phenomena in a more satisfactory manner than do capillaric models. The statistical theory leads to a differential equation of motion of the fluid which is a modification of that of Darcy; notably a new macroscopic quantity is introduced which is termed "dispersivity." This quantity is indicative of the sideways dispersion which a stream of fluid undergoes when it is passing through the porous medium. Under certain statistical assumptions outlined in the paper, the dispersivity becomes a constant of the porous medium. The new differential equation of motion of the fluid is discussed in detail and some indications about applications are given. A.

532.51 : 537.313

8950. A general variational principle for dissipative systems. J. W. HERIVEL. *Proc. Roy. Irish Acad. A*, **56**, *No.* 4, 37–44 (*April*, 1954).

A general variational principle is put forward for dissipative systems and is shown to apply, in unchanged form, to a general dynamical system with dissipation, to the motion of perfect and viscous fluids, and to the flow of electricity in linear conductors. A.

532.528 : 778.534

Cinematograph photographs of injected water vapour. *See Abstr.* 9875

532.54 : 534.23

The acoustic resistance of a pipe orifice to steady-state fluid flow. *See Abstr.* 9007

532.57 : 621.317.79

8951. Relation between the velocity profile and the sensitivity of electromagnetic flowmeters. J. A. SHERCLIFF. Letter in *J. appl. Phys.*, **25**, 817–18 (*June*, 1954).

It has often been stated that the circular flowmeter is insensitive to the form of the velocity profile and hence to the presence of upstream disturbances. This is shown to be erroneous except in the case of axially symmetrical flow. A narrow rectangular channel is to be preferred if a sensitivity independent of velocity profile is required. S. C. DUNN

532.59

8952. Wave motions and the aerodynamic drag on a free oil surface. J. R. D. FRANCIS. *Phil. Mag.*, **45**, 695–702 (*July*, 1954).

Laboratory experiments are described in which air is blown over a viscous oil in a wind tunnel. At low windspeeds no waves at all appear on the surface, but at a sharply defined critical windspeed small ripples appear, some of which are unstable and grow quickly. The phenomenon is thought to be the instability predicted by Kelvin, which is not observed clearly on the sea. The sort of waves which grow by Jeffreys' "sheltering" process do not appear until a higher windspeed than the critical one. The aerodynamic drag on the oil surface was also measured, and it appears that once the critical windspeed has been exceeded, the oil acts rather similarly to water, so far as drag forces are concerned. A.

CAPILLARITY 532.6

532.612.4 : 532.73 : 541.64

8953. Surface tension of high polymer solutions. F. OOSAWA AND S. ASAKURA. Letter in *J. chem. Phys.*, **22**, 1255 (*July*, 1954).

An equation is given for $\Delta\sigma$ the surface tension increment of a solution, and it is shown how knowledge of surface tensions can indicate the variation with concentration of the end-to-end distance of polymers. T. C. TOYE

532.623 : 551.574.1

8954. Photographic investigation of the projection of droplets by bubbles bursting at a water surface. C. F. KIENTZLER, A. B. ARONS, D. C. BLANCHARD AND A. H. WOODCOCK. *Tellus*, **6**, 1–7 (*Feb.*, 1954).

Bubbles of air reaching the air-water interface burst and eject liquid droplets into the air to heights large compared to their diameter. Photographic evidence is introduced to prove the existence of a jet of liquid which upon breaking up produces these droplets. The jet is shown to be produced by the collapse of the bubble cavity. The droplets are found to be of the order of one-tenth of the bubble size, for the range investigated (0·2 to 1·8 mm dia.), each bubble producing about 5 droplets. The droplet-producing mechanism is essentially the same for fresh and sea water or sea water with oleic acid surface film. The time required for the bubble to burst and the jet formation to take place is found to be proportional to the bubble size. The sea-water droplets produced by this mechanism leave, upon evaporation of the water, salt nuclei having the size range observed by Woodcock (1952). It is suggested that such bursting of bubbles plays an important role in the natural production of air-borne sea-salt nuclei at the sea surface. A.

532.65

8955. The rate of spread of liquid pools over horizontal solid surfaces and between approaching parallel flat plates. E. B. BIELAK AND E. W. J. MARDLES. *J. Colloid Sci.*, **9**, 233–42 (*June*, 1954).

Measurements have been made of the rate of radial spread and graphs giving the dimensions of the pools after different intervals of time and with different surface finishes have been prepared for several liquids on different kinds of surfaces; also derived graphs

relating the rate of radial flow with film thickness, etc., have been included. Movement is complex and specific to the surface and chemical character of the liquid, but it is possible to follow the effect of adsorbed surface films and to correlate movement with the periphery resistance (Jamin effect). With the use of binary mixtures of liquids, correlations have been found for rate of radial spread with several properties, such as the coefficient of friction, adhesion, contact angles and swelling. Any increase in surface activity consequent upon molecular disaggregation is accompanied by a higher rate of movement, increased adhesion, etc. Some liquids are more sensitive to the roughening of surfaces than others. The effect of viscosity usually appears to be masked by surface effects, etc., but with liquids of low Jamin resistance, apart from the initial and later stages of spreading, an approximate relation between time and the radius of the pool can be obtained both for a liquid spreading on a horizontal surface and between approaching parallel plates. A.

532.65

8956. Speed of circulation in droplets. F. H. GARNER, A. H. P. SKELLAND AND P. J. HAYCOCK. Letter in *Nature* [*London*] **173,** 1239 (*June* 26, 1954).

Speed of vortex circulation in droplets of nitrobenzene falling through a solution of "Cellofas" in tap water was measured by plotting the paths of Al particles, included in the droplets, by inspection of ciné photographs. It is hoped that this and future work will indicate factors causing circulation.

T. C. TOYE

MOLECULAR THEORY OF LIQUIDS 532.7

532.7 : 533.7

8957. The equilibrium properties of assemblies of non-spherical molecules. J. S. ROWLINSON. *Trans Faraday Soc.*, **50,** 647–56 (*July*, 1954).

A simple statistical theory is used to examine the effects of the orientational forces between molecules on the second virial coefficient of a gas, on the vapour pressure of a liquid, on the rectilinear diameter, on Trouton's constant, on the heat capacity of a liquid at constant volume, and on the surface tension of the liquid. The agreement between theory and experiment is satisfactory. A.

532.7 : 534.22/.23

Ultrasonic propagation and its relation to molecular structure in the diols. *See Abstr.* 8997

532.7 : 534.22

8958. The calculation of the free volumes of liquids from measurements of sonic velocities. F. C. COLLINS AND M. H. NAVIDI. Letter in *J. chem. Phys.*, **22,** 1254–5 (*July*, 1954).

An equation for velocity of sound in molecular dimensions is derived from Rayleigh's velocity of sound equation and the free volume equation of state (Eyring and Hirsehfelder). The results have the same order as other methods and have the advantage of not depending upon the geometry of the free volume. T. C. TOYE

532.7 : 669

8959. The structure of liquid metals. B. R. T. FROST. *Progress in metal physics, Volume* 5, 96–142 (1954) [see Abstr. 9871 (1954)].

A comprehensive review discussing the following topics: Indirect experimental evidence for the atomic structure of liquid metals (e.g. from electrical resistance, viscosity, mechanical strength), theory of the liquid state, stability of liquids, X-ray diffraction studies (theory, experimental methods, results for liquid Na, Li and tabularly for other metals), neutron diffraction studies; liquid alloys (experimental determination of activity, immiscibility, X-ray examination, density, viscosity, surface tension and diffusion studies, freezing and nucleation, liquidus and solidus curves). 119 references. F. P. WOHLFARTH

532.71 : 536.7

8960. Osmosis in the light of the theory of irreversible thermodynamic processes. K. POPOFF. *Ann. Phys.* [*Paris*] **9,** 261–8 (*May–June*, 1954) *In French.*

A discussion of interphase mass and energy transfer through a plug which introduces only one kinetic parameter. R. O. DAVIES

532.711

8961. Virial expansion of the osmotic pressure in the Donnan membrane equilibrium. T. L. HILL. *J. chem. Phys.*, **22,** 1251–2 (*July*, 1954).

Two methods for refinining the usual Donnan treatment of the Donnan membrane equilibrium are introduced and compared. One method is to apply the McMillan–Mayer solution theory while the second method involves modifying the Donnan treatment to include Debye–Hückel corrections to activity coefficients and osmotic pressure expressions. A.

532.72

8962. Diffusion across an interface. P. L. AUER AND E. W. MURBACH. *J. chem. Phys.*, **22,** 1054–9 (*June*, 1954).

Ideal diffusion in the sense of Fick's law in a heterogeneous system composed of two liquids is discussed by means of a three-region model where the two bulk liquid regions adjoin a third region which characterizes the liquid-liquid interface. When diffusional resistance terms are defined in the usual manner, three classes of interfacial diffusion may be conveniently described by the model. It is found that extraordinary resistance to diffusion at the interface gives rise to perturbations in the observed concentration profile of the bulk regions; these perturbations diminish with time and disappear in the limit of vanishing resistance. A.

532.72

8963. Theory of thermal diffusion in liquids and the use of pressure to investigate the theory. W. M. RUTHERFORD AND H. G. DRICKAMER. *J. chem. Phys.*, **22,** 1157–65 (*July*, 1954).

A theory of thermal diffusion in liquids is presented which involves: (1) a molecular interpretation due to Denbigh of the results of the thermodynamics of irreversible processes in terms of regular solution theory; (2) a correction for differences in shape and size of the molecules. Thermal diffusion measurements have been made to 10 000 atmospheres pressure

on a series of binary mixtures in a single stage system. The results indicate that the theory is satisfactory. A.

532.72

8964. Thermal diffusion in binary liquid mixtures of molecules of simple symmetry. R. L. SAXTON, E. L. DOUGHERTY AND H. G. DRICKAMER. *J. chem. Phys.*, **22**, 1166–8 (*July*, 1954).

A single-stage two-cell apparatus for measuring thermal diffusion in liquid mixtures has been developed. Thermal-diffusion measurements are presented for a series of binary mixtures of molecules of simple symmetry over a range of temperature from 5°–55°C. The theory (reported in the preceding abstract) applies quite satisfactorily. The results indicate that the proposed measure of the cohesive energy

$$H_i = \left(T\frac{\partial p}{\partial T}\right)_i \left(V - T\frac{\partial V}{\partial T}\right)_i,$$

gives reasonably quantitative results. A.

532.72

8965. The effect of pressure on thermal diffusion in *n*-paraffin hydrocarbon–CS_2 mixtures. W. M. RUTHERFORD AND H. G. DRICKAMER. *J. chem. Phys.*, **22**, 1283–7 (*Aug.*, 1954).

Thermal diffusion measurements have been made to 10 000 atmospheres at 40°C and 78°C for the systems: *n*-hexane (20%)–CS_2 (80%), *n*-heptane (20%)–CS_2 (80%), *n*-octane (20%)–CS_2 (80%). The data are interpreted in terms of a modified regular solution theory presented previously. The results are consistent with the theory and the regularities indicate that a general quantitative theory of thermal diffusion is possible. A.

532.72

8966. Thermal diffusion in mixtures of tetrachloroethane with normal paraffin hydrocarbons. R. L. SAXTON AND H. G. DRICKAMER. *J. chem. Phys.*, **22**, 1287–8 (*Aug.*, 1954).

Thermal diffusion measurements have been made on a series of binary mixtures of normal paraffin hydrocarbons with tetrachloroethane over a range of temperatures from 5–55°C. The results are analysed in terms of a previously published theory. The size of hole left by the hydrocarbon seems independent of chain length up to an eight or nine carbon chain. If the moving segment is assumed to be eight carbon atoms long, the size of hole left by the segment is independent of total chain length. A.

532.72

8967. Thermal diffusion in binary mixtures of CS_2 and hexane isomers. W. M. RUTHERFORD, E. L. DOUGHERTY AND H. G. DRICKAMER. *J. chem. Phys.*, **22**, 1289–92 (*Aug.*, 1954).

Thermal diffusion measurements have been made for binary mixtures of CS_2 and the five isomeric hexanes at atmospheric pressure and under pressure to 10 000 atmospheres. The data, measured in two different types of apparatus, are consistent. The results indicate that the further the deviation from spherical symmetry, the larger the value of the steric correction factor ψ. Thus, for mixtures of molecules of the same size and cohesive energy, the more spherically symmetrical will concentrate at the cold wall. A.

532.73 : 541.182.6 : 541.64

8968. On interaction between two bodies immersed in a solution of macromolecules. S. ASAKURA AND F. OOSAWA. Letter in *J. chem. Phys.*, **22**, 1255–6 (*July*, 1954).

If two large parallel plates are immersed in a solution of rigid spherical macromolecules and their distance is smaller than the diameter of these molecules the space between them is filled with solvent only and a force comparable to osmotic pressure occurs. This force is expressed in a formula, which is also applied to two more cases: two plates in a solution of rodlike macromolecules and two spherical bodies in the same solution as the first case. In each case the force is attractive. It is of importance in the behaviour of suspended particles in solutions of macromolecules.

A. J. TAYLOR

532.739.2

8969. A cryoscopic study of the solubility of uranium in liquid sodium at 97·8°C. T. B. DOUGLAS. *J. Res. Nat. Bur. Stand.*, **52**, 223–6 (*May*, 1954).

The equilibrium temperatures, at various stages of melting, of three samples of sodium were measured with a standard deviation of 0·001 deg. One sample contained uranium in compact form, and one contained finely divided uranium. Impurities lowered the freezing points of all the samples by approximately 0·035 deg., but the sodium containing finely divided uranium was found to have a freezing point higher than those of the other two samples by 0·005 deg., an effect that may be due to a partial purification of the sodium by the uranium. After extrapolation to no impurity, the freezing points of the three samples agree within 0·002 deg. Allowing for errors, it is concluded that the solubility of uranium in liquid sodium at 97·8°C probably does not exceed 0·05% by weight and may actually be many times smaller. A.

532.77 : 541.132

8970. The application of the Debye–Hückel theory to polyions. I. The range of applicability of the Debye limiting law. H. J. G. HAYMAN. *J. chem. Phys.*, **22**, 1234–42 (*July*, 1954).

The Debye limiting law has been used to deduce an expression for the electrical work which must be done to build up a polyion from the corresponding single ions in extremely dilute solutions containing various (appreciable) concentrations of 1–1 electrolyte. The case of an infinite straight rigid polyion having charges at equal intervals along its length was treated in greater detail, and a corrected expression was obtained for the above-mentioned electrical work, which makes allowance for the finite size of the polyion charges and takes some account of the steric effects due to the remainder of the polyion molecule. The error due to the high electric potential ψ surrounding such a polyion which invalidates the Debye approximation of replacing $\sinh(\varepsilon\psi/kT)$ by $\varepsilon\psi/kT$ was evaluated by numerical integration of the Poisson–Boltzmann equation. The integration was started at a considerable distance from the polyion on the assumption of cylindrical symmetry and continued at closer distances on the assumption of

spherical symmetry surrounding each polyion charge. The results obtained indicated that the error involved in using the simple Debye limiting law formula would seldom be more than a few per cent, provided the concentration of the 1–1 electrolyte was rather low (not more than about N/100). A.

532.783

8971. Liquid crystals. P. CHATELAIN. *Bull. Soc. Franç. Minéral. Crist.*, **77**, 323–52 (*Jan.–March*, 1954) *In French.*

A review of work on the subject during the last twenty years with special reference to the nematic state. An extensive bibliography is given.

L. G. CARPENTER

532.783 : 539.13

Nuclear relaxation and quasi-crystalline structure of liquids. *See Abstr.* 9441

MECHANICS OF GASES 533

533.12 : 535.417

8972. A chrono-interferometer for measuring gas density during transient flows. C. W. CURTIS, R. J. EMRICH AND J. MACK. *Rev. sci. Instrum.*, **25**, 679–82 (*July*, 1954).

An interferometer for measuring gas density as a function of time during a transient flow is described. This is an absolute instrument capable of measuring density changes over an approximate range from 10^{-2} to 10^{-5} g/cm^3. Since the instrument requires only small optical components, it is relatively simple and inexpensive to construct. A.

533.12 : 536.423.15

Orthobaric density of nitrous oxide. *See Abstr.* 9185

533.16 : 533.7

8973. The viscosity of gases and the theory of corresponding states. E. WHALLEY. *Canad. J. Chem.*, **32**, 485–91 (*May*, 1954).

The viscosity of gases is examined using the theory of corresponding states. The curve of reduced viscosity plotted against reduced temperature is compared with the theoretical curves obtained for several intermolecular potentials. The approximate Sutherland equation gives the best fit and it is suggested that this be used to extrapolate viscosities to high temperatures where experimental data are not available. The reduced viscosity–reduced temperature plot can be used for estimating the viscosities of simple gases from critical data, or critical data from the viscosities. A.

533.16 : 536.23 : 537.56

8974. The viscosity and thermal conductivity of a completely ionized gas. S. CHAPMAN. *Astrophys. J.*, **120**, 151–5 (*July*, 1954).

The general formulae for the first approximations to the viscosity μ and thermal conductivity λ of a mixed gas are evaluated for a completely ionized gas. The results are expressed in terms of μ and λ for "corresponding" purely ionic or purely electronic neutral gases, composed of equal numbers of positive and negative similar ions, or of positive and negative electrons, of the same temperature and number density (supposing that such particles could continue to exist together without transformation or recombination); the symbols for μ and λ for such gases will be distinguished by the subscripts i and e. Numerical illustrations are given in two cases. For ionized atomic hydrogen, μ is practically the same as μ_i, and μ_e is much smaller; λ is about $\frac{1}{3}\lambda_e$, and λ_i is much smaller. For a gas composed of completely stripped atoms of atomic number 20 and atomic weight 40, the ionic fields of force are strong, their effective diameters are large, and their mean free paths small; the values of μ_i, and (particularly) of λ_i, are much less than those of μ_e and λ_e. The ions reduce μ to about $\mu_e/30$, and n to about $\lambda_e/50$. A.

533.5

8975. A large-diameter reciprocating-action vacuum valve. G. L. FOX. Note in *Rev. sci. Instrum.*, **25**, 616 (*June*, 1954).

533.5

8976. A note on the use of indium for removal of mercury vapor in vacuum systems. R. D. HEYDING AND E. A. FLOOD. *Canad. J. Chem.*, **32**, 591–2 (*June*, 1954).

It is shown that metallic indium adsorbs mercury vapour quite rapidly after a short induction period. It is suggested that indium may be found useful in removing traces of mercury vapour from vacuum systems. A.

533.6.011.3 : 534.222.2 : 536.75

8977. Contribution of the change of entropy to the directions of spines of shock polar. T. KAWAMURA. *J. Phys. Soc. Japan*, **9**, 396–400 (*May–June*, 1954).

The directions of spines of shock polar in two-dimensional iso-energetic flow of a compressible fluid are calculated and compared with approximate results as obtained by neglecting the variation of entropy change on the successive streamlines experienced at the shock wave surface. The series of numerical values of the spines show certain deviations, which would be due to the neglect of the entropy variations. The deviations are considered when the angle of inclination of the shock wave to the uniform stream is large, and the flow behind the shock wave is subsonic, which is a case of frequent occurrence in the study of the detached shock wave problem. Thus the present analysis indicates the necessity of computing the entropy variation in such a problem. A.

MOLECULAR THEORY OF GASES 533.7

533.7

8978. On the solution of Boltzmann's equation for a Lorentzian gas; application to weakly ionized gases. M. BAYET, J.-L. DELCROIX AND J.-F. DENISSE. *C.R. Acad. Sci.* [*Paris*] **238**, 2146–8 (*May* 31, 1954) *In French.*

For a Lorentzian gas the collision operator in Boltzmann's equation is linear and its eigenfunctions are spherical harmonics; the eigenvalues may be

calculated when the law of force is known. These properties are used to study the behaviour of weakly ionized gases. E. H. SONDHEIMER

533.7

8979. Theory of gases. XX. J. DUCLAUX. *C.R. Acad. Sci.* [*Paris*] **238,** 2372–3 (*June* 21, 1954) *In French.*

Discussion of possible objections to the author's theory [see, e.g. Abstr. 8564 (1950)]. E. H. SONDHEIMER

533.7

8980. The molecular flow of gases. D. W. STOPS. Letter in *Brit. J. appl. Phys.*, **5,** 269 (*July*, 1954).

Emphasizing the analogies between molecular movement at extreme dilution and radiation, the author comments on a paper by Rossmann and Yarwood [Abstr. 2363 (1954)]. R. EISENSCHITZ

533.7

8981. On the phase transition. S. KATSURA. Letter in *J. chem. Phys.*, **22,** 1277–8 (*July*, 1954).

Preliminary notice of results obtained by applying the Bragg–Williams approximation to a lattice gas. The main theorem (which the author conjectures to be general) is that the canonical ensemble yields a van de Waals type isotherm rather than one like Mayer's. R. O. DAVIES

533.7 : 532.7

The equilibrium properties of assemblies of non-spherical molecules. *See Abstr.* 8957

533.7 : 533.15

8982. A note on the flow of gases through very fine tubes. G. W. SEARS. *J. chem. Phys.*, **22,** 1252–3 (*July*, 1954).

It is shown that Knudsen's laws of flow for rarefied gases must be modified for very fine tubes. Gas flow occurs by diffusion of molecules in the adsorbed layer on the tube walls as well as in the gas phase. When the tube dimension is comparable to the mean free path in the gas film, the two flow mechanisms become comparable in effectiveness. A.

533.7 : 533.16

8983. The temperature dependence of viscosity of non-polar gases. B. N. SRIVASTAVA AND M. P. MADAN. *Proc. Nat. Acad. Sci. India A*, **21,** *Pt III–VI*, 254–60 (1952).

The Chapman–Enskog theory of the transport properties of gases is utilized, in conjunction with the Lennard-Jones 12 : 6 power potential energy function for molecular interaction, to calculate the inter-molecular force constant ε and the low-velocity collision diameter r_0 from the experimentally observed viscosities of gaseous argon, oxygen, nitrogen and neon at different temperatures. The values of the collision integrals given by Hirschfelder, Bird and Spotz for the 12 : 6 model have been used for this purpose. In contrast with the previous workers, ε has been calculated for different ranges of temperature to discover if it varies with temperature. It has been found that for argon, oxygen and nitrogen, ε has a larger value at higher temperatures than at lower temperatures, in general agreement with the authors' investigations of the thermal diffusion of argon published elsewhere. A.

533.75

8984. The quantum behaviour of compressed gases. H. G. DAVID AND S. D. HAMANN. *Trans Faraday Soc.*, **49,** 711–16 (*July*, 1953).

The pressure-volume relationships of hydrogen and deuterium have been studied at 64·5°K and 78·9°K and at pressures between 150 and 1250 atm. The results show a marked quantal inflation of the pressure which is in good agreement with the predictions of a quantized Lennard-Jones and Devonshire theory of the gases. A.

533.75 : 536.71

8985. On the van der Waals equation of state. C. JORDAN. *Acta phys. Hungar.*, **3,** *No.* 3–4, 335–8 (1954) *In French.*

The van der Waals point is not identical with the critical point, and the method of calculating the parameters a and b by using two of the three equations for the van der Waals point is arbitrary. One would get different parameters by using two others. Taking the kinetic energy per molecule per degree as constant, a and b are determined by calculating the minimum difference between $3/2R$ and the experimental kinetic energy. The calculated parameters for CO_2 and C_2H_4 give a reasonable approximation. C. TURNER

VIBRATIONS . ACOUSTICS 534

534.113

8986. Second mode vibrations of the Pochhammer–Chree frequency equation. C. W. CURTIS. Letter in *J. appl. Phys.*, **25,** 928 (*July*, 1954).

The velocity and frequency of a high-frequency longitudinal oscillation observed in a Mg bar (12 ft long and 1·5 in. dia.) subjected to an air shock at one end, agree with those predicted for the second mode of oscillation by the Pochhammer–Chree equation. Such a mode of oscillation has never previously been recorded [see Abstr. 8278 (1953)]. The group velocity is lower than that of the pulse corresponding to the first Pochhammer mode, and the two superposed groups of waves can be clearly identified in a series of strain-time graphs obtained by means of resistance gauges at various positions along the bar. J. G. OLDROYD

534.121.1

8987. Comments on the paper by Alan G. Mencher "Epicentral displacement due to elastic waves in an infinite slab." A. S. GINZBARG. Letter in *J. appl. Phys.*, **25,** 804 (*June*, 1954).

See Abstr. 146 (1954). The original paper is criticized as regards the difficulties arising from differentiation of the step functions. It is pointed out that these difficulties could have been avoided by using a displacement potential linearly increasing with time instead of a step function; in this way, the contribution of a shear wave to the displacement is unaffected by any changes in the singularity of the time dependence of the source. H. J. H. STARKS

534.121.1

8988. Reply to the comments of Arthur S. Ginzbarg. A. G. MENCHER. Letter in *J. appl. Phys.*, **25,** 804 (*June*, 1954).

See preceding abstract. Mencher denies that difficulties arose in the differentiation of the step

functions. He asserts that Ginzbarg's proposals are unnecessary and that the same results can be obtained using a step function. It is shown that, for the compressional waves, the δ-function is essential, but for the shear arrivals the δ-function does not appear. H. J. H. STARKS

534.121.2 : 534.321.4

8989. Vibrations of Indian musical drums regarded as composite membranes. B. S. RAMAKRISHNA AND M. M. SONDHI. *J. Acoust. Soc. Amer.*, **26**, 523–9 (*July*, 1954).

Raman first observed that the overtones of the Indian musical drums, *Mridanga* and *Thabala*, form a sequence of five natural harmonics, and that they result from nine modes of vibration, some of which are (approximately) degenerate. After a brief review of the previous work on the subject, a theory of these drums is developed in the present paper on the basis that the drumheads of these instruments can be regarded as circularly symmetric membranes with a radial step discontinuity in the density. The eigenvalues and eigenfunctions of such a composite membrane are obtained, and it is then shown from a numerical calculation that for suitable ratios between the densities and radii of the two parts, the frequencies and the modes of vibration are in accordance with Raman's observations. Measured values of the frequencies of the first nine modes confirm the approximate degeneracies and the harmonicity indicated by the theory and establish the adequacy of the composite membrane as a mathematical idealization of these drumheads. A.

534.121.3

8990. Measurements of the tonal characteristics of carillon bells. F. H. SLAYMAKER AND W. F. MEEKER. *J. Acoust. Soc. Amer.*, **26**, 515–22 (*July*, 1954).

High-quality magnetic-tape recordings were made of individual bells at the carillon location, including bells cast by Meneely and Company, Watervliet, New York; Van Aerschodt, Louvain, Belgium; John Taylor and Company, Loughborough, England; Franz Schilling Söhne, Apolda, Germany. Measurements made on the tapes with a sound analyser, Stroboconn and an automatic level recorder gave the relative tuning, the relative amplitudes at the microphone position and the decay rates of the various components in the bell tone. A.

534.131

8991. Radial and torsional vibrations of a cylindrically aeolotropic annulus. A. M. SENGUPTA. *Indian J. theor. Phys.*, **1**, 125–32 (*Dec.*, 1953).

Free radial and torsional vibrations of a circular annulus having small thickness and possessing the same type of cylindrical aeolotropy as considered by Carrier (1943) are discussed. A.

534.131

8992. Transverse vibrations of a symmetric tapered reed. A. LEITNER AND E. A. HIEDEMANN. *J. Acoust. Soc. Amer.*, **26**, 509–10 (*July*, 1954).

The tapered reed, used in ultrasonic whistles, is a symmetric and homogeneous bar of rectangular cross-section, uniform in the centre and uniformly tapered to a sharp edge at each end. It is vibrating transversely under free-free conditions in the plane of the taper, and in its lowest symmetric mode; i.e. it must be mounted at the nodes. The authors have calculated the frequencies and positions of the nodes for such bars, combining the exact methods of Rayleigh and Kirchhoff for bars of uniform and tapered cross-sections, respectively. The main problem is that of joining the two different solutions at the junction of the two regions. Results were obtained for a representative range of values of the ratio of length of tapered portion to total length. The effect of the surrounding medium has not been considered. A.

534.141.4

8993. Oscillations of the jet in a jet-edge system. II. J. V. BOUYOUCOS AND W. L. NYBORG. *J. Acoust. Soc. Amer.*, **26**, 511–14 (*July*, 1954).

For previous part, see Abstr. 5361 (1954). The use of low velocity dyed-liquid jets to obtain a motion picture history of the jet oscillation in a jet-edge system is discussed. A group of photographs selected from such a history is presented, illustrating the jet configuration between orifice and edge at various intervals in the cycle of the jet motion. These photographs are then compared with the profiles predicted by a theory of one of the authors. It is found that when the actual divergence of the jet stream is accounted for, good agreement exists between the theoretical profiles and those observed. A.

543.211

8994. Wave motion in plastic-elastic strings. J. W. CRAGGS. *J. Mech. Phys. Solids*, **2**, 286–95 (*June*, 1954).

The equations of motion of an extensible string are obtained for transverse motions sufficiently large to alter the tension. Examples are given to show how particular problems may be solved, either by the method of characteristics or by a general numerical technique. A.

534.213

8995. A remark on the transmission of sound pulses in a 2-layered liquid half-space. J. L. URETSKY. Letter in *J. Acoust. Soc. Amer.*, **26**, 582–3 (*July*, 1954).

Pekeris obtained a solution for the transmission of sound in a 2-layered liquid half-space by dealing with the Hankel transform of the potential function. It is shown that in satisfying the boundary conditions at the interface his method involves an unjustified interchange of a differentiation and an integration. A.

534.213 : 534.44

8996. Transient wave analysis in a linear time dependent material. R. D. GLAUZ AND E. H. LEE. *J. appl. Phys.*, **25**, 947–53 (*Aug.*, 1954).

Considers a body which under stress exhibits an elastic, a viscous and a retarded elastic response. For the particular case of a constant velocity applied at the end of a semi-infinite bar, the transient stresses, strains and velocities are found by the method of characteristics. From this solution can also be obtained the stresses for the case of a constant stress applied at the end of a semi-infinite bar. By superposition problems involving finite bars can also be solved. For a constant velocity applied at the end of the bar an integral expression is derived for the stress at that end as a function of time. A.

534.22/.23 : 532.7

8997. Ultrasonic propagation and its relation to molecular structure in the diols. T. A. Litovitz, R. Higgs and R. Meister. *J. chem. Phys.*, **22**, 1281–3 (*Aug.*, 1954).

Measurements of viscosity, ultrasonic absorption and velocity were made in a group of associated organic liquids, known as the diols. Included in the measurements were ethanediol, two isomers of propanediol and three isomers of butanediol. In these liquids the values of absorption ranged from 1·66 to 2·20 times that value calculated from the Stokes formula. The effect of the structural differences indicated the following, when the addition of CH_2 groups was considered, (1) an increase in shear viscosity, (2) an increase in adiabatic compressibility, (βad) and (3) an increase in the ratio of $\alpha_{obs}/\alpha_{calc}$. Effects caused by isomeric changes were (1) an increase in βad and (2) an increase in $\alpha_{obs}/\alpha_{calc}$ as the (OH) groups were brought closer together. It was concluded that a relationship existed between the ratio of $\alpha_{obs}/\alpha_{calc}$ and βad. Measurement of absorption *v.* temperature in ethanediol over a viscosity range of 24 : 1 indicated that the difference in activation energy of shear and compressional viscosity could be no greater than 0·1%. A.

534.22

8998. Investigation of ultrasonic velocities in liquids by a new method. B. Ramachandra Rao and K. Subba Rao. *Proc. Indian Acad. Sci. A*, **39**, 132–6 (*March*, 1954).

See Abstr. 6554 (1953). The principle and the experimental details of the method of determining ultrasonic velocities in transparent liquids along with a brief description of the crystal holder designed to suit this method are given. Ultrasonic velocities determined for about ten common liquids are tabulated along with those obtained previously by different methods. The main features of this method are briefly discussed. A.

534.22

8999. Dispersion in ultrasonic velocity in methane induced by high pressures. A. Lacam. Letter in *J. Phys. Radium*, **15**, 381–2 (*May*, 1954) *In French.*

Ultrasonic velocities in methane have been measured at 25 and 50°C with pressures up to 1000 atm. The maximum frequency employed was 4900 kc/s. From 400 atm. the effect of increasing frequency is to diminish the velocity; this is in the same direction as the effect due to increasing temperature at pressures above 220 atm. It is noted that dispersion appears where the kinematic viscosity goes through a minimum. F. E. HOARE

534.22

9000. Ultrasonic relaxation and its relation to structure in viscous liquids. T. A. Litovitz, T. Lyon and L. Peselnick. *J. Acoust. Soc. Amer.*, **26**, 566–76 (*July*, 1954).

Measurements of ultrasonic propagation of longitudinal waves in pentachlorobiphenyl were made over a large range of viscosity at frequencies in the range 7·5 to 52·5 Mc/s. The data at low viscosities demonstrated the presence of both shear and compressional viscous processes. Measurements in the relaxation region indicated that a single relaxation time theory could not explain the results. Several possible explanations are discussed. The data at very high viscosities showed a frequency-independent absorption loss per wavelength, which indicated the possible presence of a non-relaxational type of hysteresis. The thermal coefficient of the high-frequency velocity was measured and found to be about twice the coefficient of the low-frequency velocity. The thermal coefficients of the instantaneous elastic moduli are compared to the low-frequency elastic moduli. It was concluded that the differences in the temperature dependence of these moduli could be related to the changing degree of order in the liquid. A.

534.22 : 532.7

The calculation of the free volumes of liquids from measurements of sonic velocities. *See Abstr.* 8958

534.22 : 532.7 : 539.133

9001. Ultrasonic velocity in mixtures containing aniline and nitrobenzene. I. Gabrielli and G. Poiani. *Ricerca sci.*, **24**, 1039–44 (*May*, 1954) *In Italian.*

Molecules of aniline and nitrobenzene, in spite of their structural similarity, often appear with different physical properties. Using the method of Lucas and Biquard, the authors have measured the ultrasonic propagation velocity and the adiabatic compressibility for six binary pairs of mixtures containing aniline or nitrobenzene with: acetone, ethyl alcohol, benzene, chloroform, ether, toluene. In most cases one does not find appreciable differences, but the data obtained do not exclude the possibility that sometimes the two molecules show some slight difference in the propagation of elastic waves. A.

534.22 : 539.32

9002. Electro-acoustic measurement of modulus of elasticity. A. Bressi. *Alta Frequenza*, **23**, 51–61 (*April*, 1954) *In Italian.*

Describes electro-acoustic apparatus for measuring the modulus of elasticity of a concrete block by observing the velocity of propagation of elastic wave through it. V. G. WELSBY

534.222.2

9003. The propagation of shock waves in self-gravitating gas spheres. Z. Kopal. *Astrophys. J.*, **120**, 159–71 (*July*, 1954).

The aim of the present paper has been to investigate the existence and properties of progressing waves in self-gravitating gas spheres which arise as a result of a single central explosion. It is shown that if the kinetic energy released by such an explosion is very small in comparison with the gravitational and thermal energy of the gas sphere in its equilibrium (pre-explosion) state, the system of partial differential equations governing a compressible spherical flow can be made to depend on a single variable $\xi = t\psi/r$, where t denotes the time; r, the radial distance; and ψ is a constant which, in the case of flow headed by a shock wave, is related to the exponent α of the equilibrium density distribution $\rho \sim r^{-\alpha}$ by $\psi = 2/\alpha$. The finiteness and positivity of the equilibrium pressure in front of the shock wave is found to require that

$1 < \alpha < 3$; while the finiteness and positivity of the total energy contents inside the shock has restricted the range of possible variation of α to $1{\cdot}5 < \alpha < 2{\cdot}5$ in spheres consisting of monatomic gas. The case $\alpha = 2{\cdot}5$ (corresponding to $\psi = \frac{4}{7}$) is singular for any value of γ and has already been treated in a preceding paper of this series. To each value of α within the limits of the foregoing inequality there corresponds a flow characterized by a definite constant Mach number M. An analysis of the relation between α and M based on extensive numerical integrations reveals, moreover, that, for shocks of great strength, the values of α are very insensitive to M and approach their upper limit asymptotically; while with diminishing M, the constant α decreases until, for approximately $M = 1{\cdot}6$, $\alpha = 2$, corresponding to $\psi = 1$, i.e. to a shock whose radius increases uniformly for all time. Detailed numerical integrations have been undertaken for seven particular values of M, and a summary of the results is given. A.

534.222.2

9004. Geometrical acoustics. I. The theory of weak shock waves. J. B. KELLER. *J. appl. Phys.*, **25**, 938–47 (*Aug.*, 1954).

In the first part the discontinuity conditions in an arbitrary continuous material are deduced for a general (i.e. possibly curved) discontinuity surface. It is then shown that only three types of discontinuities are possible—shocks, contact discontinuities and phase-change fronts. In the second part of the acoustic discontinuity conditions are deduced and specialized to a perfect fluid without heat conduction. Then a first-order partial differential equation is obtained for the location of an acoustic shock front. This equation can be solved, as in optics, by means of rays. The variation of shock strength along a ray is then determined (this is one main result of this paper). Coefficients of reflection and transmission for an acoustic shock at a contact discontinuity in the basic flow are also obtained. Finally, the results are exemplified by an analysis of the shock tube. A.

534.222.2

9005. Shock propagation in brass. H. BECKER. Letter in *J. appl. Phys.*, **25**, 1066–7 (*Aug.*, 1954).

Comments are made on the papers of Shreffler and Deal [Abstr. 2749 (1953)] and Savitt [Abstr. 1122 (1954)] on the free surface motion of brass plates under explosive detonation. A clearer picture of the behaviour of the plates is obtained by replotting the results to show the lines of demarcation for velocity zones in the plates. It appears that the velocity zones are defined by specific deflection modes, some of which may exist in thick but not in thin plates and that there may be changes in mode shape.

H. J. H. STARKS

534.222.2 : 523.72

Space-charge wave amplification in a shock front. *See Abstr.* 8864

534.23

9006. The transmission of sound through thin elastic plates. J. E. YOUNG. *J. Acoust. Soc. Amer.*, **26**, 485–92 (*July*, 1954).

The transmission of sound through thin elastic plates set in a plane infinite baffle or an infinite duct is discussed in some detail. A two-dimensional configuration is considered in both instances. The problems then are the transmission through a strip set in an infinite baffle and transmission through a plate set in a duct supporting lowest mode propagation. These systems make it possible to indicate in a formal manner how the boundary conditions affect transmission. The notion of bending impedance is used as a means of categorizing the mounting conditions. Experimental investigations of the transmission through circular plates in ducts of the same cross-section were carried out. It is shown that the transmission loss varies with the manner in which the plates are mounted. The conditions under which this behaviour is predictable are discussed. A.

534.23 : 532.54

9007. The acoustic resistance of a pipe orifice to steady-state fluid flow. J. K. WOOD. *J. Acoust. Soc. Amer.*, **26**, 492–4 (*July*, 1954).

Steady-state flow data for a viscous, incompressible fluid are plotted as acoustic resistance against volume velocity extended to a volume velocity corresponding to a Reynolds number of one. The acoustic impedance at zero frequency is then equal to the resistance predicted from Poiseuille's equation for laminar flow. The value of the Poiseuille resistance depends on the effective length of the pipe which in turn requires a reliable value of the end correction. By using end corrections that have proved adequate for periodic flow, the computed resistance agrees with the experimentally measured resistance in the region where resistance is independent of volume velocity or flow for orifice diameters from 0·106 cm to 1·28 cm. The resistance v. flow curve has a bend point at a Reynolds number of about ten for all orifice diameters measured. The resistance depends on the flow beyond a Reynolds number equal to ten, increasing with constant slope. A.

534.23 : 534.83

9008. On the pressure field of a uniformly moving concentrated force. N. H. KEMP. Letter in *J. Acoust. Soc. Amer.*, **26**, 450–1 (*May*, 1954).

The equation for the perturbation force, when a fluid is streaming in direction of negative x with given subsonic velocity is established on the assumption of a distribution of external body forces harmonic in time, and the equation is reduced to the classical form of the inhomogeneous wave equation solved in Lamb's *Hydrodynamics* (*p.* 501). It is suggested that a sign error occurs in this treatise. The final expression for the pressure field is obtained by integration by parts, using the vector identity $A \operatorname{div} \boldsymbol{B} = \operatorname{div}(A\boldsymbol{B}) - \boldsymbol{B} \operatorname{grad} A$. The theory refers to the effect of forward speed on noise of aircraft propellers.

J. A. WILCKEN

534.23 : 532.7

9009. Ultrasonic hysteresis in viscous liquids. T. A. LITOVITZ AND T. LYON. *J. Acoust. Soc. Amer.*, **26**, 577–80 (*July*, 1954).

The ultrasonic absorption coefficients for longitudinal waves in glycerol and pentachlorobiphenyl are measured over the frequency range from 7·5 to 70 Mc/s. The measurements are made in the range

of viscosities from 10^5 to 10^7 poise so that the ultrasonic frequencies used are well above the main relaxation frequencies associated with viscous flow processes in these liquids. The results indicate that the absorption coefficient per cm can be represented by the expression $\alpha = B + Hf$, where B and H are constants and f is the ultrasonic frequency. The constants B and H in both liquids are found to decrease with increasing temperature, exhibiting an "apparent" activation energy of about 24 kcal/mole and 12 kcal/mole for the pentachlorobiphenyl and glycerol respectively. It is concluded that the results found here indicate that both terms B and Hf found in α could best be explained by assuming that one or more distributions of relaxation times exist. It is suggested that ultrasonic hysteresis in both liquids and solids have a common origin indicating that the hysteresis effect in liquids is not related to the viscous flow mechanism causing the absorption maximum at lower frequencies and viscosities. A possible mechanism offered for the hysteresis loss is the coupling of the acoustic energy into heat energy due to the anharmonicities in the lattice structure. A.

534.23 : 536.48

Ultrasonic measurements in magnetically cooled helium. *See Abstr.* 9193

534.23 : 539.213

9010. On the elastic absorption of amorphous materials. P. G. Bordoni and M. Nuovo. *Ricerca sci.*, **24**, 773–81 (*April*, 1954) *In Italian.*

The velocity and the absorption of extensional vibrations propagating along a thin rod have been measured for some amorphous materials (ebanit, rhodoid) as a function of temperature, in the range corresponding to their transition from the pseudo-solid to the liquid state. It has been found that absorption increases steadily with temperature, reaching very high values, while in the same range velocity undergoes a strong decrease. The imaginary part of the Young modulus has been also measured for other amorphous bodies, which exhibit a reversible transition from pseudo-solid to liquid state (colophony, beeswax, picein). The curves obtained show a well-marked maximum at a temperature within the transition range, and this seems to point to the existence of some kind of relaxation. A simple formal theory has been proposed, in order to explain the above results, by means of a general hypothesis on the behaviour of amorphous bodies. A.

534.231.3

9011. The conception of sound impedance. W. Willms. *Acustica*, **4**, 427–32 (1954) [=*Akust. Beih., No.* 1 (1954)] *In German.*

After some considerations of the concept of acoustic impedance the author gives a characterization of the transmission properties of "acoustic elements" by means of a matrix, and in connection therewith considers the basic equations of the acoustic field by analogy with the undulatory and transmission theory. A three-dimensional admittance vector is introduced. By the definition of a "Poynting vector" it is possible to give a more exact formulation of the acoustic flux and expressions for a surface impedance and the impedance of a complete system. Finally the author points out, by means of an example, that there exist fundamental differences between the acoustic and electric field. A.

534.231.3

9012. Acoustic impedance of a right circular cylindrical enclosure. F. Biagi and R. K. Cook. *J. Acoust. Soc. Amer.*, **26**, 506–9 (*July*, 1954).

At low frequencies, the acoustic impedance of a right circular cylindrical enclosure (containing air, or other gases) is affected by the cooling effects of the walls. Analytical expressions for the temperature distribution have been obtained, and computations of the effect on the impedance are given in the form of plotted correction factors. These corrections are used in making absolute pressure calibrations of condenser microphones at low frequencies. The solution presented for the average temperature distribution applies also to the heat-conductivity problem of a uniform volume distribution of sinusoidal heat sources, which are considered to be in phase, inside a cylindrical enclosure having isothermal walls. A.

534.232

9013. Proposal for standardization of the expression for the power delivered by an ultrasonic projector. M. Degrois. *Ann. Télécomm.*, **9**, 99–102 (*April*, 1954) *In French.*

The value normally given for the mean ultrasonic intensity, W/cm^2, the overall power emitted ÷ the total surface of the quartz crystal, is misleading unless the emissive power is uniformly distributed over the surface. A definition is suggested, of the "active surface," as being $\frac{7}{8}$ of the total, and the definition is arrived at after discussion of diagrams showing energy distribution at different power values, compared with definition of bandwidth in telecommunication, and some numerical examples. J. A. Wilcken

534.232

9014. A new microphone of high directivity. K. Tamm and G. Kurtze. *Acustica*, **4**, 469–70 (1954) [=*Akust. Beih., No.* 1 (1954)] *In German.*

A new uni-directional microphone of high directivity is described which is handy because of its extension in only one direction and the most important constituent of which is a slotted tube, coupled to a suitable microphone. A.

534.232 : 621.395.61

9015. An acoustic lens as a directional microphone. M. A. Clark. *Trans Inst. Radio Engrs Prof. Group on Audio*, **AU-2**, 5–7 (*Jan.–Feb.*, 1954).

An acoustic lens combined with a conical horn can be used to obtain a highly directional microphone without some of the disadvantages of the parabolic microphone. The directional characteristics can be calculated satisfactorily if the horn is assumed to provide uniform flooding of the lens aperture. A.

534.232 : 534.372 : 621.395.62

9016. The mechanical transient effect of the electrodynamic loudspeaker. N. Mayer. *Funk u. Ton*, **8**, 239–43 (*May*, 1954) *In German.*

The mechanical system of such a loudspeaker, if subjected to an electrical impulse, will undergo a transient oscillation, whose time constant can be

determined from the electrical impedance. The equivalent circuit is shown and the equations of motion obtaining in the general case derived. From tests taken in an anechoic room, where the loudspeaker under test is excited by a second loudspeaker, values for the damping factor are obtained which agree well with calculated figures. Calculated figures for the time constant and an equation for critical damping are also given. H. G. M. SPRATT

534.312.9 : 541.18.053

9017. Ultrasonic nebulization, a new method for the production of aerosols. G. PICKROTH AND F. SPITZENBERG. Note in *Naturwissenschaften*, **41**, *No.* 9, 209 (1954) *In German.*

This is a brief advance statement on the possibility of using ultrasonic methods for producing dense aerosols (1 cm^3 of fluid in 6 l of air) for medical treatments requiring inhalation. The size of the droplets shows a small spread about a maximum of $2{\cdot}5\ \mu$; control is easy and an exact dose can be given. H. J. H. STARKS

534.321.9 : 616–073

9018. On the use of ultrasound for tumor detection. H. T. BALLANTINE, JR, T. F. HUETER AND R. H. BOLT. Letter in *J. Acoust. Soc. Amer.*, **26**, 581 (*July*, 1954).

Results are reported on recent investigations to test the possibility of detecting brain tumors by ultrasonic scanning. It is concluded that though compensated ultrasonograms (sound shadow pictures) may contain some information on brain structure, they are too sharply "noise"-limited to be of unqualified clinical value. A.

534.372

9019. The damping of bending vibrations of thin metal sheet by adhesive layers. II. H. OBERST, G. W. BECKER AND K. FRANKENFELD. *Acustica*, **4**, 433–44 (1954) [=*Akust. Beih., No.* 1 (1954)] *In German.*

For Pt I, see Abstr. 2171 (1954). Since Pt I appeared progress has been made in the development of the materials having high internal energy losses, which are used for damping the vibrations of thin sheet metal. The technique for measuring the dynamical properties of those materials has been completed. The advances made are described in the present paper. The possibility of comparing different damping substances is discussed. It is shown how a maximum of damping efficiency in the desired ranges of frequency and temperature can systematically be obtained in the case of plasticized high polymers mixed with appropriate inorganic filling materials. Finally problems of the practical applications of the damping mixtures are discussed. A.

534.372 : 536.48

9020. Elastic and anelastic behavior of some metals at very low temperatures. P. G. BORDONI. *J. Acoust. Soc. Amer.*, **26**, 495–502 (*July*, 1954).

Vibration frequency and damping have been measured a a function of temperature in the range 4·5°K–300°K, for lead, copper, aluminium and silver rods. Damping has been found to reach a maximum near $\frac{1}{3}$ of Debye temperature, owing to a new relaxation effect. Near the absolute zero both damping and frequency changes vanish as a high power of temperature. A.

534.39

9021. Radiation pressure and non-isotropic nature of acoustic pressures at high intensities. V. GAVREAU AND M. MIANE. *C.R. Acad. Sci.* [*Paris*] **238**, 2148–50 (*May* 31, 1954) *In French.*

A balance was used to measure the radiation pressure exerted on conical objects (apex facing source) by plane waves emanating from an ultrasonic vibrator operating in air at a frequency of 77·1 kc/s and an amplitude of $2{\cdot}42\times10^{-4}$ cm. The effect on the radiation pressure of differences in the angle of the cone or in the nature of the surface of the cone or of small steps or projections on the cone faces is described. The results are explicable if it is assumed that the acoustic radiation pressure has directional properties. It is suggested that the velocity of sound increases at high intensities; the results indicate that the velocity at 145 db is 347 m/sec at 20°c compared with the theoretical value of 340 m/sec. H. J. H. STARKS

534.44

9022. The possibility of applying sound spectrography in acoustical investigations. W. KALLENBACH. *Acustica*, **4**, 403–7 (1954) [=*Akust. Beih., No.* 1 (1954)] *In German.*

An arrangement consisting of a heterodyne analyser, a tape recorder and an oscillograph is described which allows the sound spectrum to be photographed as a function of time. Examples from research on bells and industrial noises show the possibilities of application of the method. A.

534.44

9023. Analyzing ultrasonic pulses by the split reflector method. R. A. MCCONNELL. *J. Acoust. Soc. Amer.*, **26**, 563–5 (*July*, 1954).

Frequency modulation within a carrier frequency pulse in the sonic microwave region is measured in this paper by comparing any span of several carrier cycles with every other such span along the length of the pulse. The method is especially suitable for modulation in the range of 0·1 to 5%. A.

534.642

9024. The horn as a coupling element for acoustic impedance measurements. T. D. NORTHWOOD AND H. C. PETTIGREW. *J. Acoust. Soc. Amer.*, **26**, 503–6 (*July*, 1954).

Impedance tube methods of testing acoustical materials are restricted to frequencies below the value for which the wavelength is approximately equal to the largest lateral dimension of the tube. Above this frequency, extraneous modes of propagation interfere with measurements. The restriction is a serious one for typical acoustical materials that cannot adequately be sampled in less than 1 square foot. It has been found that the difficulty may be circumvented by using a horn to couple a large sample to a small impedance tube. Comparisons between horn and tube measurements have been made for a range of absorptive materials. A.

534.7 : 612.85

Physiological acoustics. Hearing. *See Abstr.* 9861–6

534.78

9025. Intelligibility of different speech materials. I. J. Hirsh, E. G. Reynolds and M. Joseph. *J. Acoust. Soc. Amer.*, **26**, 530–8 (*July*, 1954).

Articulation scores for nonsense syllables and for monosyllabic, disyllabic and polysyllabic words were obtained as a function of the cut-off frequency of low-pass and high-pass filters and also as a function of signal-to-noise ratio at different noise levels. Results indicate that eliminating all frequencies above or below 1600 c/s does not impair the intelligibility of words seriously. The intelligibility of a word is a direct function of the number of syllables in the word and monosyllabic words are more intelligible than nonsense syllables. The relation between the intelligibilities of each word type and nonsense syllables is not the same when the system is impaired by filtering as it is when the system is impaired by noise. The implications of the lack of consistency from one experiment to the other for the generality of the concept of *articulation index* is discussed. A.

534.78

9026. Short-term autocorrelation analysis and correlatograms of spoken digits. R. Biddulph. *J. Acoust. Soc. Amer.*, **26**, 539–41 (*July*, 1954).

Autocorrelation techniques provide a method of displaying speech sounds in a form which differs significantly from conventional sound spectrograms. The autocorrelation function $\psi_{11}(\tau)$, of a signal $I(t)$ is defined by

$$\psi_{11}(\tau) = \underset{T\to\infty}{\text{Limit}} \frac{1}{T}\int_0^T I(t)I(t-\tau)dt$$

Delay τ introduced in the speech signal appears as ordinate in these displays, time t as abscissa, and magnitude of the resulting correlation function $\psi_{11}(\tau)$ is shown by the density of the pattern. Characteristic features of the displays are discussed and evaluated in terms of the mechanism of the correlation process. Data considered are limited to the ten spoken digits one, two, . . . nine, "oh." A.

534.839

9027. Acoustical measurements on antinoise varnishes. G. G. Sacerdote. *A.T.A. Ricerche*, **6**, *No.* 5, 401–7 (1953) *In Italian.*

The efficiency of an anti-noise treatment is defined by the measurement of dissipative parameters of a treated vibrating plate. A suitable acoustical method is described. A.

534.843

9028. Normal frequency statistics annd excitation statistics in rooms. Model study with electromagnetic waves. M. Schröder. *Acustica*, **4**, 456–68 (1954) [=*Akust. Beih., No.* 1 (1954)] *In German.*

It is shown that the non-accidental degenerations of regular rooms can be effectively split up by minute deviations from geometric symmetry. With a cube of 20 cm length, for instance, the average degree of degeneration is 24 at 3 cm wavelength. But a difference between the three dimensions of 0·1 cm only suffices to make the spacing statistics a purely random one. The excitation statistics of the normal modes is then investigated. Here again a degenerate case is the starting point. A rectangular cavity is excited at the central point of one of its surfaces. In this manner only one-fourth of the normal modes will be excited. But introducing a tiny perturbing element with a volume of (wavelength)^3 into the resonator results in all the modes being excited according to a purely random law. Though the present investigation is of interest within the domain of room acoustics predominantly, all measurements have been performed with microwaves in metallic cavities, because of their high Q which is in the order of some 10^4. Thus the individual resonances can be resolved even at higher ratios of room dimensions to wavelength. A.

OPTICS . RADIATION . SPECTRA 535

535.11 : 535.24

9029. Measurement of emissivity in normal direction and emissiyity in directions within the solid angle 2π for the surfaces of some plastic materials. G. Parolini. *Ricerca sci.*, **24**, 1059–71 (*May*, 1954) *In Italian.*

The results of the measurements are reported and their overall correspondence to those which can be anticipated on the basis of the electromagnetical theory is checked. Relations are obtained permitting the computation of the energy emitted by the surfaces within the temperature range of 10° to approximately 100°c. For measurement methods see Abstr. 7250–1 (1954). A.

535.2

9030. Hyperspace, radiation pressure and total radiator. On congruences of straight lines and normals. P. Rossier. *Arch. Sci.* [*Geneva*] **6**, *No.* 6, 379–80, 381–2 (1954) *In French.*

In m-dimensional space, the total radiation is proportional to the $(m + 1)$th power of the temperature. A radiator below absolute zero, in space with an odd number of dimensions would radiate energy at an increasing rate; in space with an even number of dimensions it would absorb energy. Any congruence of straight lines may be regarded as a set of tangents to two surfaces, but not necessarily as a set of normals. The conditions for a congruence of lines to form a set of normals are investigated. N. Corcoran

535.23.08–15

9031. A proposed method of infra-red detection based on thermal conversion of radiation. C. T. J. Alkemade. *Physica*, **20**, 433–6 (*July*, 1954).

A new method of i.r. detection is proposed, based on the change in black-body radiation of a black strip when it is heated by the radiation to be measured. The application of a photoconductive cell is proposed for the detection of the black-body radiation which occurs in the near i.r. region at room temperature. Some informative calculations on the detection limit will be given, showing that the expected results are good when compared with that of bolometers, etc. A.

535.24 : 628.9 : 621.327.3

9032. Rapid method for finding the flux from medium-pressure and high-pressure mercury vapour lamps. G. Parolini. *Elettrotecnica*, **41**, 257–60 (*May*, 1954) *In Italian.*

The author has determined, for 9 different types of

mercury vapour lamps, a two-component reduction factor relating the luminous flux to the luminous intensity in the normal direction. This factor can be used to obtain values of flux, to an accuracy of a few per cent, from measurements of luminous intensity. J. W. T. WALSH (R)

535.241

9033. Radiation characteristics of semicircular, circular and rectangular surface sources. A. I. MAHAN AND W. F. MALMBORG. *J. Opt. Soc. Amer.*, **44**, 644–53 (*Aug.*, 1954).

The results of a theoretical study of the radiation characteristics of semicircular, circular and rectangular surface sources have been presented when these surface sources radiate uniformly over their surfaces and obey Lambert's cosine law. Equations for all three types of sources have been derived giving the total flux falling on an elementary receiving area when this elementary receiving area has arbitrary co-ordinates and its surface normal arbitrary direction cosines. The classical method of surface integration has been used in each case. These equations are very general in form so that a large number of the equations already published for these three sources become special cases of these equations for which either the co-ordinates or the direction cosines of the surface normal of the elementary receiving area have particular values. These equations are equally applicable to problems for which the previously designated elementary receiving area becomes the source and the semicircular, circular and rectangular areas the receiving areas. A simple translation and rotation of co-ordinates also makes it possible to consider the equally important problems for which the sources are permitted to have arbitrary co-ordinates and surface normals arbitrary direction cosines. With these equations in this form, it becomes possible to calculate the total flux falling on the elementary receiving area in the presence of an array of semicircular, circular and rectangular surface sources having arbitrary co-ordinates and surface normals with arbitrary direction cosines. One numerical example is included for each of these three sources showing how these equations may be used to determine the total flux falling on the elementary receiving area when it is limited to particular planes. A.

535.247

9034. A new projection-comparator microphotometer. J. T. ROZSA AND C. G. MOON. *J. Opt. Soc. Amer.*, **44**, 562–5 (*July*, 1954).

Describes the design and performance of the "N.S.L. Spec-Reader." Pertinent criteria of densitometers are presented, discussed and conclusions drawn as to optimum features. A.

535.247.4 : 544.61

9035. A contribution to the development and understanding of flame photometry. C. T. J. ALKEMADE. *Utrecht: The University* (1954) 171 *pp.*

Details of design and performance are given for a photometer for chemical analyses of alkali metals in blood serum. Solutions are sprayed into propane, acetylene or town's gas/air flames. A light chopper, glass colour filters, photomultiplier and amplifier system lead to an a.c. galvanometer. Limits to accuracy in this and other photometers are discussed, including those due to background flame radiation, self-absorption, mutual interference between elements caused by changes in chemical dissociation or ionization, flame pulsations, flow variations, spray interference and non-uniformity of flame temperature. A. G. GAYDON

535.31

9036. The axicon: a new type of optical element. J. H. MCLEOD. *J. Opt. Soc. Amer.*, **44**, 592–7 (*Aug.*, 1954).

A search for a universal-focus lens has led to a new class of optical elements. These are called axicons. There are many different kinds of axicons but probably the most important one is a glass cone. It may be either transmitting or reflecting. Axicons form a continuous straight line of images from small sources. One application is in a telescope. The usual spherical objective is replaced by a cone. This axicon telescope is in focus for targets from a foot or so to infinity without the necessity of moving any parts. It can be used to view simultaneously two or more small sources placed along the line of sight. If a source of light is suitably added to the telescope it becomes an autocollimator. Like ordinary autocollimators it can be used to determine the perpendicularity of a mirror. In addition, it can simultaneously act as a telescope for a point target which may be an illuminated pinhole in the mirror. The axicon autocollimator is also a projector which projects a straight line of images into space. A.

535.311

9037. Light distribution in the image of an incoherently illuminated edge. W. WEINSTEIN. *J. Opt. Soc. Amer.*, **44**, 610–15 (*Aug.*, 1954).

The image of an incoherently illuminated edge is shown to have a simple structure with no diffraction fringes for any state of correction of the imaging system. The light distribution in the defocused image is calculated and numerical results are given. A comparison is made with the predictions of geometrical optics. A.

535.312

9038. Studies of small optical irregularities in the chemical silvering and vacuum aluminizing of glass mirrors. J. TEXEREAU. *J. Phys. Radium*, **15**, S 25–S 26 (*June*, 1954) *In French.*

The mirror surface was examined with a sensitive phase-contrast arrangement, capable of detecting differences of level between 0·2 and 50 Å, with a minimum lateral extent of 0·05 mm. The glass surface was first polished, resulting in irregularities of at most 2 Å. It was found that chemical silvering removed all trace of the polish marks, but the resulting surface was not flat to better than 5–10 Å over areas of 4–5 mm across. Vacuum aluminizing on the other hand resulted in a surface identical with the polished glass. D. G. AVERY

535.312

9039. On the determination of plane mirrors in instruments for observation. II. F. BLOTTIAU. *Rev. Opt.*, **33**, 339–51 (*July*, 1954) *In French.*

In Pt I [Abstr. 942 (1949)] systems of two mirrors

were studied, supposing equal incidences. From constructional necessity that condition cannot be fulfilled. These systems are now studied without this restriction. Systems of four mirrors are then examined and it is shown that it is equivalent to discuss the intersection of three planes. Problems of transformation by pairs of mirrors can be classified into four categories, and though it is generally said that four mirrors are always sufficient for transforming a tri-rectangular trihedron into another with the same direction placed in some manner with respect to the first, it is concluded that for one of these categories no system of four mirrors can be found, even if no restriction is given for their places in space, no system of any number of mirrors is suitable. A.

535.313.6

9040. Coma of modified Gregorian and Cassegrainian mirror systems. R. T. Jones. *J. Opt. Soc. Amer.*, **44**, 630–3 (*Aug.*, 1954).

The equivalence of the classical Newtonian, Cassegrainian and Gregorian mirror systems with respect to the first two Seidel aberrations is rederived by means of a simple congruence. The effects of arbitrary small modifications of the two-mirror systems are then studied and general formulae are derived for the effects of such modifications on the spherical aberration and coma. Spherical aberration is corrected to the third order if the amount of glass removed from one surface is replaced at the corresponding zone of the other surface (approximate expression of Fermat's principle). Modifications in which one surface is made spherical while the other is adjusted to eliminate spherical aberration result in large increases of coma for systems having the usual amplifying ratios. A.

535.317 : 535.833 : 666

9041. On the choice of glasses for cemented achromatic aplanatic doublets. W. H. Steel. *Austral. J. Phys.*, **7**, 244–53 (*June*, 1954).

It is shown that the types of glass given by tables for thin, low-aperture telescope objectives of the "crown leading" doublet form are also those most suitable for thick, high-aperture systems. The maximum focal lengths and the tolerances permissible in glass properties are given for each aperture, and the variation of these properties is considered when the thickness or wavelength of correction is changed, or the objective used with prisms. A.

535.317.25

9042. The specification of imaging properties by response to a sine wave input. J. W. Coltman. *J. Opt. Soc. Amer.*, **44**, 468–71 (*June*, 1954).

The imaging properties of an optical system can be in many cases completely specified by a function of a single variable. A convenient function is the response to a sine wave test pattern as a function of "frequency," i.e. lines/mm. The difficulty of experimentally providing such a test pattern can be avoided by measuring the response to a square wave (bar pattern) and calculating by a simple formula the corresponding sine wave response factor. The convenience of the sine wave response factor in calculating system performance is illustrated by application to a fluoroscopic imaging system. A.

535.317.5 : 537.533.33

9043. Third-order aberrations of "doubly symmetric" systems. J. C. Burfoot. *Proc. Phys. Soc.* [*London*] *B*, **67**, 523–8 (*July*, 1954).

The third-order geometric aberrations of non-rotationally symmetric imaging systems are classified, and their characteristics given diagrammatically for the case of a circular exit aperture. The systems are "doubly symmetric," that is, they retain symmetry about each of two mutually perpendicular planes. Eleven new aberrations occur, three of which are third-order distortions, three give curved image surfaces, three are analogous to coma and two to spherical aberration. A.

535.317.6

9044. Calculation of coma. B. Cuny. *Rev. Opt.*, **33**, 352–3 (*July*, 1954) *In French.*

Coma can be measured by the radius of curvature of the meridian section of the caustic on the point where it is tangent to the mean ray. It is shown that this radius of curvature can be calculated for each image, one after the other, in the same way that astigmatism is determined, using a simple formula, which is established. A.

535.317.6 : 518.5

9045. Ray tracing on the Manchester University electronic computing machine. G. Black. *Proc. Phys. Soc.* [*London*] *B*, **67**, 569–74 (*July*, 1954).

Electronic computing machinery which removes the labour of ray tracing offers a new approach to lens design in general. This paper describes methods which have been adopted successfully for tracing paraxial, meridional and skew rays with great rapidity. Formulae are described which have been employed to obtain a detailed account of the aberrations of a lens system from defined initial data in a few minutes. A.

535.317.9

9046. The primary aberrations of anamorphotic lens systems. C. G. Wynne. *Proc. Phys. Soc.* [*London*] *B*, **67**, 529–37 (*July*, 1954).

The primary aberrations are evaluated for anamorphotic systems of cylindrical lenses, and the ray-intersection patterns corresponding to the sixteen different terms are considered; ten of these sixteen terms are shown to be zero for the anamorphotic telescope. A.

535.32 : 535.345

9047. On a systematic error in the measurement of optical constants. G. K. T. Conn and G. K. Eaton. *J. Opt. Soc. Amer.*, **44**, 477–83 (*June*, 1954).

The optical constants of opaque materials are frequently determined by measuring the principal angle of incidence, $\bar{\phi}$, and the principal azimuth $\bar{\psi}$. The approximation furnished by Brewster's law is examined. The slope at $\bar{\phi}$ of the graph of R_p/R_s against ϕ is $\frac{1}{2}\cot^3\bar{\phi}\sin 4\bar{\psi}$; previous investigations omitted the factor $\frac{1}{2}$. The variation of ψ with ϕ in the neighbourhood of $\bar{\psi}$ and $\bar{\phi}$ is expanded in the form $\psi - \bar{\psi} = a(\phi - \bar{\phi}) + b(\phi - \bar{\phi})^2 + c(\phi - \phi)^2$. The parabolic term is the most important in the infrared. Therefore, whether $\phi - \bar{\phi}$ be positive or negative, $\psi - \bar{\psi}$ will be positive. Such a systematic error in $\bar{\psi}$ leads to a positive error in the measurement of refractive index. The magnitude of such an error depends

on the signal to noise ratio. It is not significant in the visible region but is relevant in the infrared. Experimental values are examined and a graphical chart enables a ready estimate to be made in any practical case. A.

535.32 : 535.345 : 535.51–15

9048. On the use of a rotating polarizer to measure optical constants in the infrared. G. K. T. Conn and G. K. Eaton. *J. Opt. Soc. Amer.*, **44**, 484–91 (*June*, 1954).

The optical constants of a surface from which plane polarized light is reflected may be determined by measuring the principal angle of incidence, $\bar{\phi}$, and the principal azimuth $\bar{\psi}$. If the polarizer be rotated and the reflected light be examined by an analyser, the intensity is modulated at twice the frequency of rotation. The resultant signal vanishes at $\bar{\phi}$, $\bar{\psi}$, a tuning condition which is unique, is easily found and is not affected by polarizing influences subsequent to the analyser. The effect of stray polarization is examined and it is shown that the quality of the polarizer affects only the sensitivity. The bearing of the signal to noise ratio on experimental errors is considered since this ratio is limited in the infrared. It is shown that the method is valuable if the extinction coefficient lies in the range $0{\cdot}4 \leqslant \kappa \leqslant 5{\cdot}5$. Outside this range the accuracy rapidly deteriorates. This limitation is shared by all techniques based on measurement of the principal angles. Experimental details and results are presented. A.

535.32 : 539.11

9049. An experimental confirmation of the Drude free electron theory of the optical properties of metals for silver, gold, and copper in the near infrared. L. G. Schulz. *J. Opt. Soc. Amer.*, **44**, 540–5 (*July*, 1954).

The optical constants n and k of Ag, Au and Cu were determined from reflectivity and from transmissivity measurements in the wavelength range of 1 μ to 3 μ. Reflectivities were measured at glass-metal interfaces by a method previously described. Transmission measurements were made on samples in the thickness range of 300 Å to 800 Å and the results fitted to curves obtained by calculation using the complete equations of electromagnetic theory. The principal conclusion is that for wavelengths longer than 2 μ the experimental values of n and k for the interior of Ag, Au and Cu agree with the values predicted by the Drude free electron theory. To obtain this agreement the ratio m^*/m of the effective electron mass m^* to the free mass m was taken equal to 0·97, 0·98 and 1·45 for Ag, Au and Cu, respectively. Also in agreement with the Drude theory it was found that the k values of Ag–Au alloys were the same for all compositions but that the n values varied directly with the d.c.resistivity of the alloys. A discussion of the anomalous skin effect and of the significance of the results for the theory of metals is included. It will be shown that the usual interpretation given to the experiments of Hagen and Rubens is not correct. A.

535.321 : 539.155.2

Precision concentration analysis of D_2O/H_2O by means of phase-contrast refractometry. *See Abstr.* 9531

535.322.4

9050. A refractometer for high refractive indices. H. Haacke and J. Hartmann. *Optik*, **11**, *No.* 8, 380–7 (1954) *In German.*

A refractometer is described in which the optical contact between the comparison half-sphere and the material under test is the zero order fringe of a Newton ring system. No contact fluid is therefore necessary. A telescope with a minification is used to allow measurements in reflected light. The glass half-sphere used allows measurements for indices up to 1·9 with an accuracy of one unit in the fourth decimal place. R. W. FISH

535.322.4 : 535.43.07

A simply constructed differential refractometer. *See Abstr.* 9138

535.323

9051. The change of the refractive index of some germanium films irradiated by intense light. K. Ishiguro and T. Hayashi. *J. Phys. Soc. Japan*, **9**, 387–91 (*May–June*, 1954).

A Rayleigh–Löwe interferometer has been modified to measure the changes of the refractive index of several germanium films when they are irradiated by the intense white light. The refractive index of the films was found to increase when the colour temperature of the irradiating light source was $\sim 3000°$K and to decrease when the temperature was $\sim 1000°$K. From the dispersion curves, it was suggested that the present effects were caused by the variation of the number of the bounded electrons and not of the free carriers. A.

535.325

9052. Index of refraction of air in the infrared. D. H. Rank and J. N. Shearer. Letter in *J. Opt. Soc. Amer.*, **44**, 575 (*July*, 1954).

New measurements are reported for the refractive index of air at about 1·5 μ. These show that the formula due to Edlén [Abstr. 4690 (1953)] predicts values of $(\mu - 1)$ too small by slightly more than one part in 1000 in the infrared region of the spectrum beyond 1 μ. R. W. FISH

535.33.03 : 535.338.4

9053. Techniques in the study of emission spectra of polyatomic molecules—the spectra of benzaldehyde and acetophenone. G. W. Robinson. *J. chem. Phys.*, **22**, 1384–8 (*Aug.*, 1954).

A rather simple method is presented for obtaining the electrodeless discharge emission spectra of polyatomic molecules. The spectra obtained for benzaldehyde and acetophenone were of very high intensity and without a trace of spectral impurities. It was possible in the case of benzaldehyde to detect over a hundred sharp bands in the region 3688–5433 Å, and to observe some structure in the "broad" emission bands of acetophenone. In both these molecules there is strong evidence that the emission involves the same upper state as does the long-wave absorption. The (0,0) band of benzaldehyde is assigned at 26 914 cm^{-1}, and that of acetophenone at 27 501 cm^{-1}. The possibility of extending the techniques to other molecules is discussed. A.

535.33.03 : 536.46

9054. Spectroscopic examination of the NH_3–HNO_3 and NH_3–NO_2 diffusion flames. M. FARBER AND A. J. DARNELL. Letter in *J. chem. Phys.*, **22,** 1261–3 (*July*, 1954).

Photographs of flame structure and some tracings of spectra, showing NH, NH_2 and OH bands, are given for NH_3 burning on concentric tubes with O_2, NO, NO_2, N_2O and liquid red fuming nitric acid. A. G. GAYDON

535.33.07

9055. Effect of background intensity on resolution. M. S. SODHA. *Indian J. Phys.*, **28,** 141–5 (*March*, 1954).

Discusses the effect of background intensity on the resolving power of spectroscopic instruments. Tables, illustrated by graphs, are given for the variation of resolving power with background intensity in case of Fabry–Perot etalon, prism, grating and reflecting echelon, and when the instrumental width is negligible. A.

535.33.07

9056. Convenient source-alignment device for a spectrometer. B. CRAWFORD, JR, R. E. NIGHTINGALE, D. L. ROTENBERG, E. R. VINCENT AND H. F. WHITE. Letter in *J. Opt. Soc. Amer.*, **44,** 574 (*July*, 1954).

A permanent attachment to a spectrometer is described having a small test-lamp adjacent to the spectrometer prism. A beam of light is then thrown back from the entrance slit along the optical axis. Experience has shown that the arrangement could be used without turning off the spectrometer. R. W. FISH

535.33.07

9057. A long path gas absorption cell. R. G. PILSTON AND J. U. WHITE. *J. Opt. Soc. Amer.*, **44,** 572–3 (*July*, 1954).

A cell especially suited for infrared analyses of components of extremely low concentrations and absorption coefficients is described. The cell can be evacuated or pressurized. With aluminized mirrors and KBr field lenses, the evacuated cell performs with a peak efficiency of 45% of incident energy at 10 m path length. Path length is adjustable by 1·25 m increments from 1·25 m to 10 m. Adjustments are simple and can be made in a matter of a few minutes with good reproducibility. The cell will attach to the Perkin–Elmer 12, 112 and 21 spectrometers with compatibility to other attachments. The optical path can be altered quickly so that the usual sampling space of the spectrometer is available. A.

535.33.07

9058. A collaborative study of Cary spectrophotometers. J. M. VANDENBELT. *J. Opt. Soc. Amer.*, **44,** 641–3 (*Aug.*, 1954).

The absorbance curves of three certified glass filters were determined in the visible range by twelve Cary spectrophotometers used in pharmaceutical laboratories. The means of values obtained for the filters are in good agreement with the certification values. Individual instrumental differences are usually minor. A.

535.33.07

9059. A new reflecting spectrograph camera. C. MOSER. *J. Opt. Soc. Amer.*, **44,** 660–3 (*Aug.*, 1954).

The camera which has been developed consists of a spherical mirror and a corrector lens with spherical surfaces. The equivalent focal length is about 900 mm and the relative aperture is *f*/4. The design is based on the theory by Argentieri and becomes a camera of the non-concentric type. The useful range of the camera is from 2500 Å to 12 000 Å. Some details of the construction and results obtained are shown. A.

535.33.07 : 535.339.1 : 541.14

9060. The use of a concave grating monochromator in photochemistry. P. DOUZOU AND S. GERSTENKORN. *C.R. Acad. Sci.* [*Paris*] **239,** 49–51 (*July* 5, 1954) *In French.*

A concave grating monochromator gives a pure spectrum of convenient intensity and without a continuous background. A modification of the Rowland mounting is described, allowing the simple measurement of the incident and transmitted radiation. Some practical details are given. R. W. FISH

535.33.07–14 : 535.343.4–14

9061. Molecular microwave oscillator and new hyperfine structure in the microwave spectrum of NH_3. J. P. GORDON, H. J. ZEIGER AND C. H. TOWNES. Letter in *Phys. Rev.*, **95,** 282–4 (*July* 1, 1954).

The device described can be used as a very stable oscillator, a nearly noise-free microwave amplifier, or as a high-resolution spectrometer, resolving lines of width 8 kc/s. A focuser using a quadrupolar electric field selects from a beam of NH_3 molecules those in high inversion states, focusing them into a high Q cavity, where emissions are induced by an r.f. field. Self-sustaining oscillations ($\sim 10^{-8}$ watts) have been produced; under other conditions, near a resonance, the device acts as an amplifier. Used as a spectrometer, it has resolved new magnetic satellites to the NH_3 (2, 2) and (3, 3) inversion transitions, and has resolved a structure in the quadrupole satellites. The magnetic satellite is due to reorientation of the H spins, and for (3, 3) (23 870 Mc/s) is ~70 kc/s out from the main line. This type of focuser could select rotational states for molecules with high dipole moments. J. HAWGOOD

535.33.07–15

9062. A simple infra-red grating spectrometer for use in analysis. J. GAUNT. *Atomic Energy Res. Establ.* [*Harwell*] *Rep. C/R,* 1398, 5 + x *pp. figs.* (1954). Also in *J. sci. Instrum.*, **31,** 315–18 (*Sept.*, 1954).

A spectrometer which can be built for a small cost has been designed for use as an analytical tool. Design and performance are described. The use of filters for cutting out overlapping spectral orders is discussed and the transmission characteristics of some infrared transmitting filters are given. Examples of the application of this instrument to the routine analysis of heavy water are included. A.

535.33.07–15

9063. Comments on the article "Spectrometers with echellette gratings in the infrared between 0·9 and 3 μ." P. JACQUINOT AND G. HEPNER. Letter in *J. Phys. Radium,* **15,** 375 (*May*, 1954) *In French.*

The criticism previously made [Abstr. 3281 (1954)] of the Finkelstein mounting must be modified by

consideration of variation of dispersion with angle of diffraction. G. F. LOTHIAN

535.33.07–15

9064. Calibration of infrared spectrometers in the wavelength region 15–25 μ. V. ROBERTS. Letter in *J. sci. Instrum.*, **31**, 226 (*June*, 1954).

It is concluded that the wave-numbers of some water vapour bands given by Marrison [Abstr. 7153 (1952)] are in error, and a corrected table is given. G. F. LOTHIAN

535.33.07–15

9065. High resolution spectroscopy in the infrared. D. H. RANK. *J. Phys. Radium*, **15**, 517–18 (*June*, 1954) *In French.*

A review of the author's recent work [Abstr. 3983 (1953)]. A resolution of 145 000 has been obtained at 4100 cm^{-1}; wavelengths have been determined by superposition of an absorption max. on a max. from an etalon with adjustable air pressure. G. F. LOTHIAN

535.33.07–15

9066. Measurements in the infrared with a caesium iodide prism. E. K. PLYLER. *J. Phys. Radium*, **15**, 519–20 (*June*, 1954) *In French.*

A 35° prism has been used in single and double passage arrangements as far as 200 cm^{-1}. Water vapour bands with a separation of 2 cm^{-1} have been resolved near 300 cm^{-1}. Short wavelengths are removed by reflection from a depolished Ag mirror and transmission through a layer of camphor black on polyethylene. G. F. LOTHIAN

535.33.07–15 : 535.824.2

A reflecting microscope for infrared absorption measurements. *See Abstr.* 9167

535.33.07–32

9067. Measurement of spark spectrum intensities in the vacuum ultraviolet with the fluorescence sensitized photomultiplier. S. E. WILLIAMS, M. R. MEHARRY, V. W. MASLEN AND R. L. FALCONER. *J. Opt. Soc. Amer.*, **44**, 654–8 (*Aug.*, 1954).

The fluorescence sensitized photomultiplier has been combined with a peak-reading pulse voltmeter to record intensities from a source of the Lyman continuum operated at a repetition frequency about 2 c/s. Intensities can be measured on a linear scale to within a few per cent. The variation of intensity with time during the 100 μsec following the pulse discharge has also been examined using sodium salicylate and calcium tungstate as fluorescent materials. A.

535.338.3

9068. The ionized helium series originating from the fifth quantum level. R. WILSON. *Monthly Not. Roy. Astron. Soc.*, **113**, *No.* 5, 557–70 (1953).

A number of the higher components of the hitherto unobserved series of ionized helium originating from the fifth quantum level (He II 5 $^2G - n\ ^2H^0$, etc.) have been detected in the spectra of stars of Draper type *Oe*5. The lines are broad but very shallow, having central depressions of the order of 1% of the continuum. They therefore require high photometric accuracy for their detection and this was achieved by the application of the Greaves–Baker method of reduction of spectrograms. One of the main features of this method consists, in essence, of the combination of the measures of a number of negatives without smoothing, thus preserving any real features. The total intensities of some of the series members were computed and compared with the results for other lines of ionized helium originating from the third and fourth quantum levels. The wavelengths of the centres of gravity of the lines were calculated using an approximation for determining the relative strengths of the fine-structure components. One member of this He II series is blended with He I λ6678 and affects previous measures of the intensity of the latter. The blending contribution is of the order of 0·2 equivalent angstroms for the stars investigated. A.

535.338.333 : 539.152.1

Spectroscopic isotope shift and nuclear deformations. *See Abstr.* 9501

535.338.334

9069. A mathematical model for the narrowing of spectral lines by exchange or motion. P. W. ANDERSON. *J. Phys. Soc. Japan*, **9**, 316–39 (*May–June*, 1954).

A simplified mathematical model of exchange and motional narrowing, here called the "random frequency-modulation model," is developed, and, to a certain extent, justified. A number of cases are treated. The one general conclusion which is common to all is that in the case of extreme narrowing the central part of the line is resonance-shaped while the wings fall off more steeply than the resonance shape; the half-width is always of order of magnitude of the mean square frequency breadth divided by the rate of motion or exchange. In two cases the model makes some quantitative approach to realism: first, the case of a single dipolar-broadened line with exchange, where the "Gaussian" assumption can be made and the results have been fitted to Van Vleck's fourth moment calculation to give satisfactory numerical answers; and second, the case of narrowing by diffusion in solids, where the "Markoffian" assumption is valid. The problem of narrowing of hyperfine structure is considered, and on this model it is found that before merging the lines draw together, a result which is confirmed by experiments. A.

535.338.4

9070. An example of determination, by approximation of the emitter, of a new spectrum produced by organic molecules. L. REINEBECK. *J. Phys. Radium*, **15**, 398–400 (*May*, 1954) *In French.*

A visible emission spectrum between 5000–6500 Å has been observed in discharges in mixtures with helium of benzene, some benzene derivatives, naphthalene, pyridine, ethylene, acetylene, butadiene, acetylene and some others. Phenyl acetylene gives the spectrum when mixed with neon or argon. The spectra of deuteroacetylenes showed that the group causing the spectrum must contain two hydrogen atoms. The new spectrum is finally assigned to diacetylene, which emits it very strongly and has the correct band structure. A. J. TAYLOR

535.338.4

9071. Emission of bands of the Schumann–Runge system ($B^3\Sigma_u^- - X^3\Sigma_g^-$) of the oxygen molecule and of the forbidden lines OI ($^3P - {}^1D_2$) of the oxygen atom. C. WENIGER AND R. HERMAN. *J. Phys. Radium*, **15**, 528–32 (*May*, 1954) *In French.*

In order to interpret these bands, which, extending

from 2100–6300 Å, are observed at atmospheric pressure in a high-tension discharge, calculations have been made of the harmonic-oscillator wave-functions up to quantum number 30, and of the anharmonically distorted functions. From the latter, the transition probabilities, wavelengths and absorption coefficients have been calculated. Tables are given. A graph is given of the temperature-dependence of the ratio of the rate of excitation of molecules to that of dissociation. The rate tends to a constant above 2000°K, and has been calculated by taking account of the various processes which can occur in the gaseous plasma. A. J. TAYLOR

535.338.4

9072. Emission of the forbidden $^3\Sigma_u^+ \rightarrow {}^3\Sigma_g^-$ bands of O_2. H. P. Broida and A. G. Gaydon. *J. Phys. Radium*, **15**, 385-7 (*May*, 1954) *In French.*

The Herzberg bands have been obtained in emission from an afterglow of O_2. Wavelengths, intensities and vibrational analysis are given; Herzberg's values for v' require raising by one unit. The bands are compared with the spectrum of the night-sky glow in the ultraviolet, and good agreement is found.

A. G. GAYDON

535.338.4

9073. An emission spectrum attributed to acetaldehyde. G. W. Robinson. Letter in *J. chem. Phys.*, **22**, 1147 (*June*, 1954).

Photographs are given which show a spectrum from 3625 to 5500 Å obtained from a high-pressure discharge in acetaldehyde with a high pumping rate. Addition of benzene increased the intensity and retarded dissociation. Several considerations show that the spectrum must be due to no emitter but acetaldehyde. The long-wave portion shows bands at a separation of about 150 cm^{-1}. A. J. TAYLOR

535.338.4

9074. Rotational analysis of the columbium oxide bands. K. Suryanarayana Rao. Letter in *Nature* [*London*] **173**, 1240 (*June* 26, 1954).

Corrections of constants derived in an earlier paper [Abstr. 736 (1953)].

535.338.4 : 535.343 : 539.132

9075. New measurements on the $A^1\Pi \leftrightarrow X^1\Sigma$ band system of AlH. P. B. Zeeman and G. J. Ritter. *Canad. J. Phys.*, **32**, 555–61 (*Aug.*, 1954).

The AlH band system at 4241 Å was produced in a large King furnace and the bands were photographed in emission and absorption in the second and third orders of a 21 ft concave grating. The vibrational and rotational constants were newly determined with improved accuracy. A.

535.338.4 : 539.132

9076. The origin of the α band of ammonia. S. Leach and G. Pannetier. *J. Phys. Radium*, **15**, 413–16 (*May*, 1954) *In French.*

Spectra given by NH_3 and ND_3 at three pressures in a Schüler-type discharge are described. Previously with ND_3 Chauvin and Leach had attributed bands at 4485 and 5205 Å to ND and this suggested that part of the ammonia α-band might be due to NH rather than NH_2. Now comparison of the NH_3 discharge, the N_3H explosion flame and the NH_3/O_2 flame show the α-band with similar intensity distribution. The 4485 band is the (0, 0) of $^1\Pi \rightarrow {}^1\Sigma$ ND, but 5205 is really due to ND_2. The whole ammonia α-band is thus due to NH_2. The electronic states are discussed and it is suggested that the transition is $^2A_1 \rightarrow {}^2B_1$ and that the HNH angle is fairly small.

A. G. GAYDON

535.338.4 : 539.132

Spectroscopic constants of molecules. I. On the ground state frequencies of diatoms of the type XX. *See Abstr.* 9468

535.338.4 : 551.594.5

Intensity distributions in nitrogen bands excited in auroras and by high-energy protons and hydrogen atoms. *See Abstr.* 9850

535.342 : 535.243 : 523.872

9077. On an error in measurements of equivalent widths. A. J. Deutsch. *J. Opt. Soc. Amer.*, **44**, 492–3 (*June*, 1954).

In the spectrophotometry of absorption lines, and especially in stellar spectroscopy, the derived equivalent widths are shown to increase with the width of the analysing slit. This effect may contribute toward the well-known general tendency for measured equivalent widths to increase as the linear dispersion decreases.

A.

535.342–15 : 535.345.6

9078. Filters for the far infrared and spectra of the methylamines from 30 to 43 μ. A. Hadni. *J. Phys. Radium*, **15**, 375–6 (*May*, 1954) *In French.*

Short wavelengths are removed by powdered KCl held between films of polyethylene. Using this, the spectra of tri-, di- and mono-methylamine are measured; the bending vibration of CH_3 and NH_2 groups is at 269·5 cm^{-1}. G. F. LOTHIAN

535.343–14 : 535.375.5

9079. Transitions of radiofrequency having two quanta and Raman effect. A. Kastler. *J. Phys. Radium*, **15**, 323–4 (*April*, 1954) *In French.*

A quantum-mechanical treatment is given to explain spectral transitions involving two electromagnetic quanta, such as those observed by Grabner and Hughes [Abstr. 6849 (1951)] for the molecule $Rb^{85}F$. G. I. W. LLEWELYN

535.343–15

9080. Remarks on the delimitation of the infrared spectrum. J. Lecomte. *J. Phys. Radium*, **15**, 491–2 (*June*, 1954) *In French.*

A given region may be conveniently described as the 1st, 2nd . . . 9th octave (beyond the visible limit at 7500 Å). This would avoid the ambiguous terms "near i.r.," "valence vibration region," etc.

G. F. LOTHIAN

535.343–15

9081. *s*-Triazine. III. The infra-red spectrum. J. E. Lancaster and N. B. Colthup. Letter in *J. chem. Phys.*, **22**, 1149 (*June*, 1954).

For Pt II, see Abstr. 8153 (1954). The infrared spectrum was taken of *s*-triazine in vapour, liquid and solid phases. The spectrum was in agreement with a D_{3h} symmetric model. Two types of band contours were found, one of which showed clear *P*, *Q* and *R* branches, which should be connected with parallel vibrations; the other type, belonging to the per-

pendicular modes, was not well defined. Some of the fundamentals were identified, but it was not possible to locate the inactive modes from the overtones or combinations. A. J. TAYLOR

535.343–15

9082. Infrared spectra of thionyl chloride and sulfuryl chloride. D. E. MARTZ AND R. T. LAGEMANN. *J. chem. Phys.*, **22,** 1193–5 (*July*, 1954).

The infrared spectra of thionyl and sulphuryl chloride have been investigated from 400 cm^{-1} to 5000 cm^{-1} with a prism spectrometer. Three of the fundamentals of $SOCl_2$ have been found and four for SO_2Cl_2. They and the various additional bands have been assigned to their appropriate symmetry species assuming $SOCl_2$ has C_s symmetry and SO_2Cl_2 has C_{2v} symmetry. A.

535.343–15 : 541.621

Spectroscopic study of an isomer of hydrogen peroxide. *See Abstr.* 9727

535.343–32

9083. The far ultraviolet absorption spectra of selected isomeric hexenes. J. T. GARY AND L. W. PICKETT. Letter in *J. chem. Phys.*, **22,** 1226–7 (*July*, 1954).

This confirms the correlation between the direction of the dipoles and the position of the $N \rightarrow V$ band. No relation has been observed between the magnitude of the moments and that of the band shift. C. TURNER

535.343.2

9084. Displacement of the absorption spectrum of cuprous oxide as a function of the temperature. S. NIKITINE, M. SIESKIND AND G. PERNY. *C.R. Acad. Sci.* [*Paris*] **238,** 1987–9 (*May* 17, 1954) *In French.*

Earlier measurements [Abstr. 4358 (1954)] are extended up to 273°K and show continuous increases of λ at higher temperatures. The lines fit a Rydberg-type equation from which are calculated ν_∞ for the yellow and red series. ν_∞ yellow $-$ ν_∞ red $=$ 1030 cm^{-1}, which accords with an infrared vibration $\nu = 1100$ cm^{-1}. G. F. LOTHIAN

535.343.2 : 539.132

9085. Study of exciton spectra in Cu_2O. S. NIKITINE, G. PERNY AND M. SIESKIND. *J. Phys. Radium*, **15,** 18 S–19 S (*April*, 1954) *In French.*

At liquid nitrogen temperatures 3 lines of a green series and 4 of a yellow have been found in thin slices of Cu_2O which can be represented by a hydrogen-like formula for an exciton. Two lines of a red series can be seen at temperatures between +20°C and −196°C. Contrary to the usual theory, the wavelengths of these lines depend strongly on the temperature. This can be explained by adding to the hydrogen-like expression a term representing multiples of an infrared crystal vibration frequency; then the above series are to be interpreted as a fundamental series and two "vibration satellites." There is, in fact, a strong infrared band in the position required by this idea. A. J. TAYLOR

535.343.2

9086. Theory of absorption spectra of unsymmetrical cyanines. G. ARAKI AND S. HUZINAGA. Letter in *J. chem. Phys.*, **22,** 1141–2 (*June*, 1954).

The absorption maximum of an unsymmetrical cyanine having two different nuclei is of shorter wavelength than the mean of the wavelengths of the corresponding two symmetrical cyanines. The square potential well method, whose energy levels are occupied by the π-electrons, and which has been useful in interpreting the spectra of symmetrical cyanines, is replaced by a Pöschl–Teller potential of which the square well is a limiting case. This potential has two parameters for each nucleus, and by fitting these it is found that they are related to the basicity of the nuclei. In short cyanines with strongly basic nuclei the potential deviates markedly from squareness. A. J. TAYLOR

535.343.2

9087. Fine structure in absorption spectrum of tricesium cobaltous pentachloride in crystalline state. S. YAMADA AND R. TSUCHIDA. Letter in *J. chem. Phys.*, **22,** 1273 (*July*, 1954).

Qualitative measurements on a single crystal at room temperature. A table of absorption coefficients for a series of bands is given. An expression for the absorption peaks is given. C. TURNER

535.343.2 : 539.132 : 548.0

9088. Vibration spectrum of crystals of hydrazine dihydrochloride. L. COUTURE AND J.-P. MATHIEU. *Ann. Phys.* [*Paris*] **9,** 255–60 (*March–April*, 1954) *In French.*

Hydrogen bonds complicate the analysis of the spectrum of the internal vibrations of the $N_2H_6^{++}$-ion. The low-frequency spectrum, due to translational and rotational vibrations has been completely analysed. C. TURNER

535.343.2 : 548.7

9089. The spectrum of crystal ions. O. HITTMAIR. *Acta phys. Austriaca*, **8,** *No.* 3, 225–33 (1954) *In German.*

Group theoretical methods for handling the spectrum in the case of a pure electric field (from the crystal) are discussed, especially with respect to the Kramers' degeneracy occurring in odd electronic states. The connection of this and time-reversal is discussed. G. E. BROWN

535.343.2–14

9090. The microwave spectrum of vinyl iodide. C. D. CORNWELL AND R. L. POYNTER. Letter in *J. chem. Phys.*, **22,** 1257 (*July*, 1954).

The microwave spectrum was taken in order to investigate the double bond character of the C–I bond, which has been observed in other vinylhalides. Sixty-nine transitions were observed in the 24 600–25 800 Mc/s region. These were assigned and the molecular and quadrupolar constants were calculated. Bragg's asymmetry parameter, which is a measure of a bond's deviation from cylindrical symmetry, was found to be of the same order as in the other vinylhalides. A. J. TAYLOR

535.343.2–14 : 537.228.5

9091. Stark effect in the microwave spectra of KCl and NaCl. P. A. TATE AND M. W. P. STRANDBERG. *J. chem. Phys.*, **22,** 1380–3 (*Aug.*, 1954).

Some further lines in the microwave spectrum of KCl have been observed at frequencies predicted by

the rotational constants given by recent molecular beam work. Measurements have been made on the Stark patterns of the $J = 2 \rightarrow 3$, $v = 0$ line of $K^{39}Cl^{35}$ and the $J = 1 \rightarrow 2$, $v = 0$ line of $Na^{23}Cl^{35}$. The dipole moments of these molecules have been determined to be $10{\cdot}1 \pm 0{\cdot}2$ Debye units for KCl and $8{\cdot}5 \pm 0{\cdot}2$ Debye units for NaCl. The KCl value is in fair agreement with the results of molecular beam investigations. A.

535.343.2–15

9092. The infrared spectrum and structure of collagen. R. M. BADGER AND A. D. E. PULLIN. Letter in *J. chem. Phys.*, **22,** 1142 (*June*, 1954).

Spectroscopic evidence makes it unlikely that the collagen structure is based on peptide links with the *cis*-configuration, or that the structure contains many such groups hydrogen-bonded to each other. A diagram is given of the polarized infrared spectrum of kangaroo tail tendon 2 μ thick, dried under tension, from which it is concluded that in the NH vibration the change of moment deviates by a maximum of 8% from the NH bond to the projection of the CN bond, that in the amide I vibration the direction is nearly parallel to the ON direction, and that the amide II vibration owes its activity largely to the contribution of the NH bend, although its frequency is mainly determined by the OCN group. A. J. TAYLOR

535.343.2–15

9093. Infrared absorption spectra of the compounds $(COCs)_2$. R. SETTON, J. LECOMTE AND L. HACKSPILL. *C.R. Acad. Sci.* [*Paris*] **238,** 2472–5 (*June* 28, 1954) *In French.*

Bands at 1560 and 1585 cm^{-1} suggest resonance between the C–O bond and the C=C and C=O bonds of the structure suggested chemically for one of the two isomers. If this isomer is left for several days, it shows bands intermediate between those of the two freshly prepared isotopes, suggesting an intermediate structure. G. F. LOTHIAN

535.343.2–15

9094. Infrared absorption spectrum of germanium. L. H. HALL, J. BARDEEN AND F. J. BLATT. Letter in *Phys. Rev.*, **95,** 559–60 (*July* 15, 1954).

The optical absorption by valence electrons in Ge has been calculated, assuming an energy band structure based on previous calculations and on cyclotron resonance experiments. Two types of electronic transition are considered following the absorption of a photon. One involves no change in the k-vector for the electron, and the other involves a change in k-vector with consequent emission or absorption of a phonon. Summation of the two effects gives an absorption band shape in qualitative agreement with experiment. D. G. AVERY

535.343.2–15

9095. Infrared reflection spectra of phosphate and arsenate crystals. G. M. MURPHY, G. WEINER AND J. J. OBERLY. *J. chem. Phys.*, **22,** 1322–9 (*Aug.*, 1954).

Crystals of KH_2PO_4, $NH_4H_2PO_4$, KH_2AsO_4 and $NH_4H_2AsO_4$ were examined in the 1–25 micron region. Data were obtained at room temperature for all four crystals, and in addition the spectra of the potassium compounds were examined below their Curie points. In order to avoid the use of thin crystal cuts required for absorption measurements, an optical system was designed which permitted recording of reflection spectra. At the low temperature an increase in the number of bands was observed, and the phosphate and arsenate spectra seemed displaced to higher frequencies. The transition from hydrogen bonding prevailing at room temperature to hydroxyl bonding below the Curie points is considered likely. A.

535.343.2–15 : 535.375.5

9096. Vibration spectra of hydrogen in potassium bicarbonate. L. COUTURE-MATHIEU. *J. Phys. Radium*, **15,** 531–3 (*June*, 1954) *In French.*

Both Raman spectra and infrared absorption spectra have been measured from 600 to 3500 cm^{-1}, and an attempt is made to analyse the spectra, assuming hydrogen bonds. C. TURNER

535.343.3/.4–15 : 539.132

9097. Infrared spectrum and thermodynamic functions of formamide. J. C. EVANS. *J. chem. Phys.*, **22,** 1228–34 (*July*, 1954).

The infrared spectra of formamide in the vapour and liquid states, and in solutions in $CHCl_3$, CCl_4, CH_3CN, H_2O and D_2O, and of sodium formamide and formamide hydrochloride were observed between 650 cm^{-1} and 3800 cm^{-1}. The effect of association on the bands was examined, where possible, in solution and in the vapour state. These infrared results were taken in conjunction with the available Raman data and an assignment of the frequencies to the fundamental modes of vibration of the molecule has been made. Thermodynamic functions have been calculated. A.

535.343.31/.4–15 : 535.375.55/.56

9098. Infrared and Raman spectra of 1, 1-dimethylhydrazine and trimethylhydrazine. E. R. SHULL, J. L. WOOD, J. G. ASTON AND D. H. RANK. *J. chem. Phys.*, **22,** 1191–3 (*July*, 1953).

Infrared spectra of 1, 1-dimethylhydrazine between 700 and 1600 cm^{-1} for the gas phase and between 700 and 3500 cm^{-1} for the liquid phase and of trimethylhydrazine between 700 and 3500 cm^{-1} for the gas and liquid phases are reported along with the Raman spectra of the two compounds. Frequency assignments are given for both compounds. A.

535.343.31/.4–15 : 535.375.5 : 536.7 : 539.132

9099. Vibrational spectra and calculated thermodynamic properties of ethyl chloride and 1, 1-dichloroethane. L. W. DAASCH, C. Y. LIANG AND J. R. NIELSEN. *J. chem. Phys.*, **22,** 1293–303 (*Aug.*, 1954).

The infrared absorption spectra of $H_3C–CH_2Cl$ and $H_3C–CHCl_2$ in the gaseous and liquid states have been obtained in the region from 2 to 38 μ with the aid of LiF, NaCl, KBr and KRS-5 prisms. The Raman spectra of the liquids have been photographed with a 3-prism glass spectrograph of linear dispersion 15 Å/mm at 4358 Å. Relative intensities and depolarization ratios have been measured for most of the Raman bands. Complete assignments of fundamental vibrational frequencies have been made, the spectra have been interpreted in detail and thermodynamic functions have been calculated for the compounds in the gaseous state. A.

535.343.31/.4–15 : 539.132 : 541.63

9100. Infrared absorption investigation on the rotational isomerism of 1, 1, 2-trichloroethane. K. KURATANI AND S. MIZUSHIMA. *J. chem. Phys.*, **22,** 1403–5 (*Aug.*, 1954).

The energy difference between the rotational isomers of 1, 1, 2-trichloroethane has been determined in the gaseous and liquid states by the infrared absorption measurements. In the solid state, only one of the rotational isomers has been found to be stable. The different behaviour in rotational isomerism between 1, 1, 2-trichloroethane and 2-methylbutane, both having the same skeletal configuration, has been explained in terms of the difference in the electrostatic part of the hindering potential. A.

535.343.31–31

9101. Electronic spectra of diatomic groups with multiple bonds. F. J. TABOURY. *J. Phys. Radium*, **15,** 419–22 (*May*, 1954) *In French.*

Complex molecules having an external diatomic group (e.g. carbonyl) are considered as pseudo-diatomic molecules, whose force constants, etc., are dependent on the nature of the rest of the complex molecule. This enables one to give a detailed interpretation of the ultraviolet spectra. Absorption curves (in the liquid phase) are given between 4000–2500 Å for acetone, acetophenone, *p*-chloroacetophenone, *p*-carboxyacetophenone, and from them are deduced Morse parabolae for the ground state and for the state in which one of the bonding electrons of the CO bond has been excited, so that the bond is effectively single. Absorption curves are also given for ketene, cyclobutanone, cyclopentanone and cyclohexanone from 25 000–40 000 cm^{-1}.

A. J. TAYLOR

535.343.32 : 539.132

9102. Molecular structure and related problems. Hydrogen bonding effect on the absorption spectra of π-electron systems. H. BABA. *Monogr. Res. Inst. Appl. Elect. Hokkaido Univ., No.* 4, 61–74 (1954).

Anomalous absorption spectra are observed for π-electron systems, when they are supposed to interact with the solvent through the formation of hydrogen bonds. Measuring the absorption spectrum of phenol in various mixed solvents, the effect of hydrogen bonding is distinguished from the normal solvent effect. The absorption band of phenol is displaced to the red by about 30 Å as a result of this effect. Several other examples of the hydrogen bonding effect on the absorption spectra of π-electron systems are recorded. The mechanism of the hydrogen bonding effect is discussed on the basis of Sklar's theory of electron migration, the resonance energy and dipole moment of the excited state being estimated. A.

535.343.32–15 : 532.73

9103. Contribution to the study of the influence of solvents on valence frequencies measured by infrared spectroscopy. M.-L. JOSIEN AND J. LASCOMBE. *C.R. Acad. Sci.* [*Paris*] **238,** 2414–16 (*June* 21, 1954) *In French.*

Using published measurements on acetone, it is found that if the frequency difference between vapour and solvent is plotted against $(n^2 - 1)/(n^2 + 2)$, where n is the solvent refractive index, the points lie on a straight line through the origin for non-polar solvents. Departures from this line for polar solvents are attributed to electrostatic polarization of the solvent by molecular orientation. G. F. LOTHIAN

535.343.32–31

9104. Solution spectra and oscillator strengths of electronic transitions of pyridine and some monosubstituted derivatives. H. P. STEPHENSON. *J. chem. Phys.*, **22,** 1077–82 (*June*, 1954).

The near ultraviolet absorption spectra of the following substances have been measured in iso-octane and ethyl alcohol solutions: pyridine, the isomeric picolines, 2- and 3-fluoropyridine, 2- and 3-chloropyridine and 2- and 3-bromopyridine. Solvent effects were observed and oscillator strengths were measured for the singlet-singlet π–π^* and n–π^* electronic transitions which occur in the spectral region 34 000 cm^{-1} to 48 000 cm^{-1}. It was found that in this spectral region the n–π^* transition is missing in the case of 2-fluoro-, 2-chloro- and 2-bromopyridine. A.

535.343.4

9105. New results for the spectra of the molecules of hydrogen and its isotopes. G. H. DIEKE. *J. Phys. Radium*, **15,** 393–7 (*May*, 1954) *In French.*

Diagrams are given of the Q-branch of the $0 \rightarrow 0$ band of Fulcher's system $(3p^3\Pi - 2s^3\Sigma)$ of the molecules H_2, HD, D_2, TH, TD, T_2. In D_2 the nuclear spin is 1 and the even lines are twice as intense. Various interactions prevent the spectra of, for example, H_2 and T_2 from being mere copies, for instance, the coupling between rotation and electronic motion has a strong effect, even the order of the lines being changed. The changes in relative intensities with the discharge conditions, and the Zeeman effect, are useful guides to classification.

A. J. TAYLOR

535.343.4

9106. Rotational spectrum of PH_3. H. H. NIELSEN. *J. chem. Phys.*, **22,** 1383–4 (*Aug.*, 1954).

Lines in the rotational spectrum of PH_3, identifiable with the rotation of the molecules in the first excited states of the frequencies ν_2 and ν_4, allow an independent test to be made of the Coriolis interaction between these states as calculated from the vibrational-rotational band spectrum. It is shown that the B values observed from the rotational spectrum for these states are consistent with those obtained from the information derivable from the vibrational-rotational spectrum. A.

535.343.4 : 539.132

9107. Vibration spectra and potential energy constants of ethylene and its deuterosubstitutes. L. M. SVERDLOV AND N. L. PACHOMOVA. *Zh. éksper. teor. Fiz.*, **26,** *No.* 1, 64–78 (1954) *In Russian.*

Calculations of the normal planar vibrations of all deuteroethylenes are reported, according to the 2 customary frequency assignments (Galloway and Barker, Rasmussen and Brittain). The first leads to difficulties in the 600–1300 cm^{-1} region and is therefore rejected. Force and action coeffs. for planar and non-planar vibrations are also determined. J. JACOBS

535.343.4–14

9108. One-to-two millimeter wave spectroscopy. V. PH_3 and PD_3. C. A. Burrus, A. Jache and W. Gordy. *Phys. Rev.*, **95**, 706–8 (*Aug.* 1, 1954).

For Pt IV, see Abstr. 5456 (1954). The $J = 0 \rightarrow 1$ rotational transition of PH_3 has been measured at $\nu_0 = 266\,944{\cdot}0 \pm 1{\cdot}0$ Mc/s ($\lambda = 1{\cdot}12$ mm). With $D_J = 3{\cdot}15$ Mc/s from infrared spectroscopy, this measurement yields $B_0 = 133\,478{\cdot}3$ Mc/s. Similarly, the $0 \rightarrow 1$ transition of PD_3 was measured at $\nu_0 = 138\,937{\cdot}98 \pm 0{\cdot}30$ Mc/s ($\lambda = 2{\cdot}16$ mm) and $B_0 = 69\,470{\cdot}41$ Mc/s was obtained by using $D_J = 0{\cdot}71$ Mc/s from infrared spectroscopy. The bond lengths in the two isotopic forms were found to be slightly different with $d_{PH} = 1{\cdot}4206 \pm 0{\cdot}005$ Å and $d_{PD} = 1{\cdot}4166 \pm 0{\cdot}005$ Å. A.

535.343.4–15

9109. Vibrational spectrum of bromotrifluoroethylene. D. E. Mann, N. Acquista and E. K. Plyler. *J. chem. Phys.*, **22**, 1199–202 (*July*, 1954).

The infrared spectrum of gaseous bromotrifluoroethylene $F_2C : CFBr$ has been investigated in the range 2–52 μ. The assignment of fundamentals parallels that for chlorotrifluoroethylene very closely. The planar vibrational frequencies in cm^{-1} are 1783(νCC), 1330(νCF), 1203(νCF), 1027(νCF), 659(νCBr), 510(δCF_2), 370(δCFBr), 311(ρCF_2) 160(ρCFBr), while the out-of-plane modes are assigned 538(βCF_2), 355(βCFBr) and 150(τ). A table of thermodynamic functions for the ideal gas is given. A.

535.343.4–31

9110. The absorption spectrum of SbS molecule. P. K. Sur. *Proc. Nat. Acad. Sci. India A*, **20**, *Pt VI*, 251–9 (1951).

A band system of the SbS molecule in the region λ3042–2470, is reported. The band heads are analysed and are found to conform to the formula $\nu = 35\,768 + 368\ (v' + \frac{1}{2}) - 1{\cdot}0\ (v' + \frac{1}{2})^2 - 411\ (v'' + \frac{1}{2}) + 7{\cdot}0\ (v'' + \frac{1}{2})^2$. Some two or three heads show abnormal discrepancy ranging up to 30 cm^{-1}. But this is in the case of very weak and diffuse bands. Seven of the bands appearing in the region λ2222 – 2116 form a part of another system lying further to the extreme ultraviolet. Both the systems are degraded towards the red. A.

535.345

9111. Comparison of the energies present on the two interior faces of a film illuminated by a parallel beam at oblique incidence. P. Tauzin. *C.R. Acad. Sci.* [*Paris*] **238**, 1985–7 (*May* 17, 1954) *In French.*

It is shown that in the general case of a beam falling obliquely on to a parallel-sided absorbing film, provided the absorption coefficient in the film is below a certain value, there is greatest energy at the exit face of the film. D. G. AVERY

535.345 : 538.22 : 666

9112. The influence of different elements on the colour and magnetic susceptibility of glass. I. Iron. J. de Jong. *J. Soc. Glass Technol.*, **38**, 57–83 (*April*, 1954).

By means of a large number of transmission measurements of different kinds of glasses in the u.v., visible and i.r. region the positions of the iron ions in the network of these glasses has been investigated. From a thorough analysis of the results in the u.v. region for glasses with comparative low iron contents, it is concluded that the ferric ions are found only in network-forming positions. From measurements in the near i.r., where there is a region of absorption at 1·2 μ due to the ferrous ions, and in the u.v. at 280 and 290 mμ, before and after solarization, it is established that the ferrous ions must also take network-forming positions. By means of magnetic-susceptibility measurements the ratio of the ferrous and ferric ions in the investigated glasses were determined. Though the magnetic measurements do not give any information about the positions of the ferrous and ferric ions in glass, nevertheless, it is still possible to conclude, by analogy with the cobalt-containing glasses investigated, that the bonding of the ferrous and ferric ions must be mainly ionic. A.

535.345. : 538.22 : 666

9113. The influence of different elements on the colour and magnetic susceptibility of glass. II. Titanium and chromium. J. de Jong. *J. Soc. Glass Technol.*, **38**, 84–8 (*April*, 1954).

The influence of titanium and chromium ions on the transmission of some glasses in the u.v. has been studied. It appears that the influence of chromium ions on the transmission of glass in the u.v. is negligible. The influence of traces of titanium on the transmission of glass in the u.v. seems to depend largely on the valency state of the titanium ions. This was confirmed by measurements on the magnetic susceptibility of titanium-containing glasses. Most probably titanium ions are surrounded by four oxygens in glass. A.

535.371

9114. Theory of concentration quenching in inorganic phosphors. D. L. Dexter and J. H. Schulman. *J. chem. Phys.*, **22**, 1063–70 (*June*, 1954).

A theory is presented for concentration quenching in solid systems, based on the migration of excitation energy from one activator centre to another and eventually to an imperfection which may act as an energy sink. Calculations are made on the dependence of the fluorescence yield on concentration, and to indicate typical activator concentrations at which appreciable quenching may be expected to occur. If the transition in the activator is of the electric dipole or electric quadrupole type, appreciable quenching may arise when the activator concentration is 10^{-3} to 10^{-2}; if it is a magnetic dipole transition, transfer will occur by exchange, rather than by overlapping of magnetic dipole fields, and the critical concentration will be of the order of a few per cent. The implications of transfer phenomena upon the observed absence of luminescence in most "pure" inorganic crystals are discussed, and it is concluded that transfer rates are so high in strongly absorbing crystals that the energy can easily migrate to a very few sinks dispersed throughout the lattice. A.

535.371

9115. Preparation of plates of boric acid glass for use in the study of luminescence. F. E. E. Germann, G. L. Lee, F. T. Brown and L. M. Guthrie. *J. Opt. Soc. Amer.*, **44**, 496–8 (*June*, 1954).

A process has been developed by which boric acid

containing an organic substance as a minor constituent, can be melted and super-cooled to form a homogeneous glass under controlled vapour pressure of water. This technique assures the attainment of a reproducible fluidity of the melt. The total water content of the glass has been determined to be about 10% by weight. Plates of the glass having dimensions of $1 \times 20 \times 40$ mm were routinely prepared. These remained highly transparent for several weeks in a vacuum desiccator. A.

535.371

9116. Distribution of electron traps in various phosphorescent forms of calcium oxide. A. CROZET. *J. Phys. Radium*, **15**, S 46–S 48 (*June*, 1954) *In French.*

The phosphorescence and thermoluminescence characteristics of calcium oxide phosphors activated by Pb, Pb–Mn, Pb–Pr, Pb–Sm, Pb–Eu were measured. The decay curves are not simple mono- or bimolecular form. Some thermal glow peaks are peculiar to specific impurities such as Pb and Eu.

G. F. J. GARLICK

535.371 : 535.51

9117. Dependence of the polarization of the fluorescence on the concentration. G. WEBER. *Trans Faraday Soc.*, **50**, 552–5 (*June*, 1954).

An equation describing the depolarization of the fluorescence resulting from intermolecular transfer has been derived. This shows that the reciprocal of the polarization is a linear function of the concentration of the fluorescent molecules, independently of the functions describing the radial and angular dependence of the probability of transfer between oscillators. Considering the transfer as due to a mechanism of coupled linear oscillators it is possible to calculate from the experimental data the distance R at which the probability of emission equals the probability of transfer for two parallel isolated oscillators. From data of Feofilov and Sveshnikoff for fluorescein, eosin and rhodamin B, R is calculated to be 26, 26 and 20 Å respectively. The value for fluorescein should be compared with the value of 50 Å calculated by Förster from the fluorescent efficiency and the overlap of the absorption and emission spectra. A.

535.371 : 535.51

9118. The metallic model and the fundamental polarization of fluorescence. E. LAFFITTE. *J. Phys. Radium*, **15**, S 37–S 39 (*June*, 1954) *In French.*

535.371 : 548.0

9119. Some problems of the theory of the luminescence of crystals. [Einige Fragen zur Theorie der Lumineszenz der Kristalle.] E. I. ADIROWITSCH [ADIROVICH]. *Berlin: Akademie-Verlag* (1953) xii + 298 *pp. In German.*

The book presents a reasonably up-to-date treatment of some theoretical aspects of luminescence in crystal phosphors. Chapter I deals with the relation of luminescence to other modes of light emission and with the spectral distribution of emission. The next chapter gives a brief history of phosphor studies and in particular of the treatment of luminescence decay processes in terms of classical and modern theory. Chapter III gives a detailed account of the energy band model for phosphors while Chapter IV applies this to decay processes in crystals giving theoretical equations for afterglow due to monomolecular, bimolecular and metastable state processes. A short chapter (V) deals with the absorption processes in phosphors and is followed by two extensive chapters dealing with the effect of electron traps on luminescence. Particular attention is given in Chapter VI to raditionless transitions, while in Chapter VII detailed consideration of trapping states in relation to phosphor characteristics are made. [This book is a translation from the Russian, and numerous references to Russian papers are given for each chapter, but other references are incomplete. There are no author or subject indexes]. G. F. J. GARLICK

535.371 : 581.14

9120. Light emission by germinating plants. L. COLLI and U. FACCHINI. Letter in *Nuovo Cimento*, **12**, 150–3 (*July*, 1954).

Seeds of wheat, corn, lentils and beans were grown in darkness to avoid phosphorescence excitation and also the formation of chlorophyll. During germination luminescence was recorded which was temperature dependent. Using aseptic conditions it was shown that the emission was proper to the seeds and not due to bacterial action and lay between 4500 and 6500 Å. For homogenized seed pulp the absolute yield was 100 000 photons/sec.g. at 20°C. Addition of very dilute H_2O_2 in water increased the emission by a large factor. G. F. J. GARLICK

535.375.5

9121. Contribution to the study of the structure of methyl nitrite by Raman spectroscopy. J. WAGNER. *J. Phys. Radium*, **15**, 526–8 (*June*, 1954) *In French.*

The Raman spectrum was measured at −80°C and +20°C. It is shown that temperature variations of intensities of some of the lines is better explained in terms of the *cis* form with a temperature variation of the amount of hydrogen bonding than in terms of an equilibrium between *cis* and *trans* forms. But the former theory does not explain the doubling of certain lines in the infrared spectrum. G. F. LOTHIAN

535.375.5 : 539.133

9122. Study of the increase of intensity of Raman lines as a function of the conjugation. M. HARRAND. *J. Phys. Radium*, **15**, 328–30 (*April*, 1954) *In French.*

From measurement of the relative intensities of the Raman lines of several groups of related compounds (e.g. CH_3–CH_2–CH_2–CHO, CH_3–CH=CH–CHO and C_6H_5–CH_2–CH_3, C_6H_5–CH=CH_2, $C_6H_5C{\equiv}$CH) it is shown that the intensity is always greatest for the compound containing the greatest number of conjugated double bonds. The observed spectra are figuratively represented. G. I. W. LLEWELYN

535.375.54

9123. Raman spectra of ortho- and para chlorophenol in the solid state at low temperatures. D. C. BISWAS. *Indian J. Phys.*, **28**, 85–92 (*Feb.*, 1954).

Raman spectra in the liquid state and in the solid state at different temperatures are recorded and compared with each other. Polarization of the Raman lines of the two liquids has also been studied. Both the liquids have yielded a few feeble extra Raman lines not reported by previous workers. The

changes in the position and intensities of the Raman lines which take place with solidification of the liquids are greater in the case of the ortho compound than in the case of the para compound. The lines 379 cm^{-1} and 499 cm^{-1} shift respectively to 388 cm^{-1} and 510 cm^{-1} with solidification of the ortho compound. Three new lines appear in the low-frequency region with the solidification of ortho chlorophenol, while six such lines appear in the case of the para compound. In the former case when the polycrystalline masses are cooled to −180°c, the intensity of the new line 26 cm^{-1} increases while that of the other two new lines remains constant. In the case of para chlorophenol, on the other hand, the intensity of the line 98 cm^{-1} increases and a new line at 155 cm^{-1} appears as the crystalline mass is cooled to −180°c. The probable causes for these changes are discussed. A.

535.375.54

9124. The Raman effect and the symmetry of the ClO_4^- ion in crystals of the perchlorates of magnesium, zinc and cadmium. A. Weil and J.-P. Mathieu. *C.R. Acad. Sci.* [*Paris*] **238,** 2510–11 (*June* 28, 1954) *In French.*

The wave-numbers of the Raman lines are tabulated. Some of the lines are broad, the width increasing with the radius of the metallic ion up to 50 cm^{-1} for the Cd salt. This causes difficulties in deciding the number of lines in each spectrum. The totally symmetric vibration shows anomalies of polarization.

G. F. LOTHIAN

535.375.55

9125. *s*-Triazine. V. The Raman spectrum. R. F. Stamm and J. E. Lancaster. Letter in *J. chem. Phys.*, **22,** 1280 (*July*, 1954).

For Pt IV, see Abstr. 9493 (1954). The Raman spectrum of molten *s*-triazine at ∼85°c has been studied using natural and polarized incident radiation (Hg λ 4358 Å). The frequency shifts, symmetry classifications and assignments of the observed lines are given.

G. I. W. LLEWELYN

535.375.55 : 539.133

9126. Study of the C=O frequency of the Raman spectrum of acetic acid pure and in solutions. S. Fénéant. *J. Phys. Radium*, **15,** 325–7 (*April*, 1954) *In French.*

The molecular configuration of acetic acid in the pure state and in solution in several organic solvents, in water, and in nitric acid, has been investigated by observation of the Raman effect, particularly the C=O frequency. The various structures deduced from the experimental results are given.

G. I. W. LLEWELYN

535.376

9127. On a new sensitization effect of electric fields on the action of X-rays on certain luminescent substances. M. Destriau. *C.R. Acad. Sci.* [*Paris*] **238,** 2298–300 (*June* 14, 1954) *In French.*

Certain mixed ZnS–CdS phosphors activated by manganese show an X-ray excited luminescence which is enhanced by an electric field applied to the phosphor. The ultra-violet excited emission shows the more usual extinction effect in the applied field.

G. F. J. GARLICK

535.376

9128. Luminescence of vitreous silica. M. Lautout. *C.R. Acad. Sci.* [*Paris*] **238,** 2409–10 (*June* 21, 1954) *In French.*

Silica irradiated in the pile shows two radioactive decay periods, one due to silicon, the other to traces of sodium. The phosphorescence does not correlate with the sodium decay and is assumed independent of impurities. Further studies using crystalline quartz freed from impurities suggest that phosphorescence is characteristic of the vitreous state, the structural disorder providing the electron traps. G. F. J. GARLICK

535.376

9129. The fluorescence of biacetyl vapor at 4358 Å. N. A. Coward and W. A. Noyes, Jr. *J. chem. Phys.*, **22,** 1207–10 (*July*, 1954).

The fluorescence efficiency of biacetyl vapour when excited by radiation of wavelength 4358 Å is independent of the number of quanta absorbed per cubic centimetre per second, almost if not quite independent of biacetyl pressure, and decreases with increase in temperature, but there seems to be a transition from one type of variation with temperature to another between 60° and 100°. Oxygen quenches the fluorescence strongly, and isobutylene quenches the fluorescence little or not at all. The marked difference in fluorescence behaviour of biacetyl when excited by 4358 Å radiation from that when excited by 3660 Å radiation as pointed out by previous authors makes desirable an attempt to correlate fluorescence with photochemical behaviour. Some suggestions are made with regard to mechanism. A.

535.376

9130. Cathodoluminescence of air, quartz and metal films. J. B. Birks and W. A. Little. Letter in *Nature* [*London*] **174,** 82–3 (*July* 10, 1954).

100 keV electrons passed through the Lenard window of a discharge tube excite luminescence in air and in quartz, but no emission is observed from metals as claimed by previous workers using much less intense excitation. [Abstr. 3462 (1951), 4449 (1953)].

G. F. J. GARLICK

535.376 : 539.13

Energy transfer in liquid scintillators under X-ray bombardment. *See Abstr.* 9442

535.39

9131. Measurement of absolute spectral reflectivity from 1·0 to 15 microns. J. T. Gier, R. V. Dunkle and J. T. Bevans. *J. Opt. Soc. Amer.*, **44,** 558–62 (*July*, 1954).

A device that can be used for the measurement of the absolute spectral reflectivity or reflectance of metals, paints, etc., is described. The unit is used in conjunction with a Perkin-Elmer Model 83 monochromator equipped with an NaCl prism for the wavelength range 1·0 to 15·0 μ. Preliminary results for MgO, polished copper, molybdenum and electrolytic gold are presented. A.

535.39 : 771.53

9132. Note on gloss measurement and tolerance of photographic paper. B. Brenner. *J. Opt. Soc. Amer.*, **44,** 494–6 (*June*, 1954).

Glossiness ranking of photographic paper samples by observers was found to have a slightly higher

correlation with gloss measurement at 22½° and 45° than at 75°. The magnitude of a usually just noticeable gloss difference was determined. A.

535.39–15

9133. Far infrared reflectances of TlCl, TlBr, TlI, PbS, $PbCl_2$, ZnS, and CsBr. W. M. SINTON AND W. C. DAVIS. Letter in *J. Opt. Soc. Amer.*, **44**, 503–4 (*June*, 1954).

Values are given between 80 and 240 μ using an Al mirror as standard. Crystal samples of CsBr, PbS and ZnS were used, and powder briquettes of the others. CsBr has a sharp reflection peak at 120 μ, suggesting its use as a material for residual ray monochromators. D. G. AVERY

535.392

9134. On the chromatic diffusion halo and other optical effects exhibited by pearls. C. V. RAMAN AND D. KRISHNAMURTI. *Proc. Indian Acad. Sci. A*, **39**, 265–71 (*June*, 1954).

Discusses the origin and character of the coloured diffusion halo exhibited by pearls surrounding the reflected image of a light source seen at their surface. Twelve photographs illustrative of various types of halo are reproduced. Other aspects of the optical behaviour of pearls are also described and discussed. A.

535.41

9135. All-dielectric high-reflecting layers. O. S. HEAVENS. *J. Opt. Soc. Amer.*, **44**, 371–3 (*May*, 1954).

A simple method is described for calculating the effect of thickness errors in systems of multilayer dielectric films. The results of its application to systems of low-index–high-index quarter-wave pairs are given. A.

535.417 : 533.12

A chrono-interferometer for measuring gas density during transient flows. *See Abstr.* 8972

535.42

9136. Experimental and theoretical study of the diffraction figure given by a circular opening half covered by a plane parallel plate. N. SÉGARD. *Ann. Soc. Sci. Bruxelles, I*, **68**, *No.* 1–2, 53–60 (1954) *In French.*

The features of the diffraction figure are obtained experimentally for a plate with half-wavelength retardation. Methods of calculating the diffraction figure are sketched for a range of retardations. The calculated values for the half-wavelength case are shown to agree in form with the experimental results. R. W. FISH

535.421

9137. Optical properties of uniform particle-size latexes. T. ALFREY, JR, E. B. BRADFORD, J. W. VANDERHOFF AND G. OSTER. *J. Opt. Soc. Amer.*, **44**, 603–9 (*Aug.*, 1954).

Polyvinyltoluene latexes having uniform particle-diameters have been prepared. Diameters range from about 100 mμ to 1000 mμ. When such a monodisperse latex is dried down to the form of a friable film, the particles spontaneously arrange themselves in a close-packed crystalline array. The structure of these crystals has been investigated by means of the electron microscope, utilizing a surface replica technique. The diameters of the particles were measured optically by three different methods: (1) for particles with diameters less than 276 mμ, the sizes were determined by dissymmetry of light scattering of dilute solutions, (2) for particles with diameters between 302 mμ and 481 mμ the sizes were determined by diffraction from the dried crystalline samples, (3) for particles greater than 595 mμ in diameter the sizes were determined by interference haloes from thin dried films of the samples. Agreement is good with particle-sizes determined from electron microscopy. The diffraction from the crystalline samples of intermediate particle-size is shown to be that for a two-dimensional grating. It is suggested that these crystalline arrays be used as spectroscopic diffraction gratings. A.

535.43.07 : 535.322.4

9138. A simply-constructed constant temperature light-scattering photometer and differential refractometer. S. R. CAPLAN. *J. sci. Instrum.*, **31**, 295–300 (*Aug.*, 1954).

The instruments have been designed for the greatest possible economy in construction, consistent with the requirements of being self-contained and capable of absolute measurement of turbidity and concentration dependence of refractive index. The photometer includes a new filter to isolate the green line of the mercury arc; a light-tight box housing the major part of the apparatus and allowing simultaneous external control of temperature, angle of observation, and addition of reagents; an optical system which permits measurement of light scattered on both sides of the incident beam; and a selected photomultiplier type IP22 compensated for fluctuations both in mains voltage and light source by means of a degenerative feed-back circuit. Transmission may be measured as well as scattering, and the photometer thus provided with its own absolute calibration standards. The precision of transmission and scattering measurements is 0·3 and 1·5% respectively. The differential refractometer is merely a modified spectrometer. It has the high sensitivity required for light-scattering work, while the results are obtained in a form peculiarly suited to the theoretical equations. A.

535.434

9139. Charge effects in light scattering by colloidal solutions. K. J. MYSELS. *J. phys. Chem.*, **58**, 303–7 (*April*, 1954).

The classical fluctuation theory is applied to light scattering by ideal solutions of colloidal electrolytes in the presence of a simple salt. The necessity of introducing the condition of electroneutrality and of an equilibrium distribution of small ions is pointed out. This leads to a relatively simple expression for the turbidity as a function of the molecular weight, charge and concentration of the colloid and concentration of the simple salt. In agreement with previous results the charge p has no effect on the apparent molecular weight when the concentration of salt is very large compared to that of the colloid, but reduces it by a factor of $(p + 1)$ when the salt concentration becomes negligible. In addition the intermediate region is covered. The effect of the various factors is presented graphically and is shown to agree qualitatively with pertinent experimental results, indicating that, as a first approximation, Debye–Hückel types of non-ideality are not involved. A.

535.434 : 541.24

An apparatus for the determination of molecular weights by light scattering. *See Abstr.* 9725

535.435

9140. On the temperature dependence of molecularly scattered light by solutions of chain molecules. H. G. Fendler, W. Husmann and H. A. Stuart. *Z. Naturforsch.*, **9a**, 552–60 (*June*, 1954) *In German.*

Describes a photoelectric apparatus for measuring angular distribution of scattered light and its calibration for absolute turbidity measurements. Solutions of polystyrene and polymethylmethacrylate are used in various pure and mixed solvents at various concentrations and temperatures of 20°–100°c. On cooling a solution there is generally a decrease of asymmetry of scattering followed by a fairly sharp increase when precipitation occurs; in the unstirred scattering cell there is a supercooling of up to 10°c before this occurs. Chain lengths (180–1800 Å) and the corresponding values of the 2nd virial coefficient in the Debye scattering equation are tabulated. G. F. LOTHIAN

535.51

9141. On the analysis of elliptically polarized radiation in the infrared region. G. K. T. Conn and G. K. Eaton. *J. Opt. Soc. Amer.*, **44**, 546–52 (*July*, 1954).

An ellipse is defined by two parameters and attention is given to the selection of a convenient pair for the specification of an elliptically polarized beam of infrared radiation. If a polar is rotated in the path of such a beam, the intensity transmitted varies harmonically with azimuth. By simple geometrical analysis of this curve the inclination and the axial ratio of the ellipse may be determined with precision. This principle forms the basis of a method for the measurement of optical constants in the infrared. The labour of computing results is overcome by a graphical technique. The ultimate sensitivity in the infrared is limited by the "noise" present in the detector. The accuracy of the method is examined in terms of the signal-to-noise ratio. It is shown that the optimal angle of incidence is the principal angle. An expression is derived for the azimuth of the incident beam which is associated with the most accurate determination of optical constants; this is less than the principal azimuth. The conclusions are presented graphically. Experimental details are given and results obtained by this and other methods are discussed. A.

535.51 : 548.1

9142. On the polycrystalline forms of gypsum and their optical behaviour. C. V. Raman and A. K. Ramdas. *Proc. Indian Acad. Sci. A*, **39**, 153–61 (*April*, 1954).

Brings to notice the remarkable optical effects exhibited by a polycrystalline form of gypsum which is different from both alabaster and satin-spar in its structure. It is not a fibrous material but consists of fine rods orientated nearly parallel to the *b*-axis of gypsum and exhibits a ready cleavage along planes perpendicular to that axis. A source of light viewed through a plate of the material exhibits, in general, three concentric circles which are polarized in a characteristic fashion. The source itself appears as a luminous point on the second or middle circle. It is shown that these circles arise by reason of the reflection of light at the boundaries between the rod-like crystals composing the material, for which the name "fascicular gypsum" is accordingly proposed. A theoretical explanation of the phenomena is given and photographs of the same are reproduced. Observations on the optical behaviour of alabaster and of satin-spar are also reported. A.

535.513

9143. Transmission of light through birefringent and optically active media: the Poincaré sphere. H. G. Jerrard. *J. Opt. Soc. Amer.*, **44**, 634–40 (*Aug.*, 1954).

The parameters necessary to define an elliptically polarized vibration, namely the azimuth, the shape, and the sense of rotation of the ellipse described by the light vector can be represented geometrically by a point on a sphere. The method was suggested by Poincaré in 1892. The theory of the Poincaré sphere is presented in detail, and its application to tracing the passage of light through doubly refracting and optically active media fully illustrated. A simple model, designed on the principles involved, is described: it is suitable for instruction and demonstration. A.

535.514.2

9144. Optical study of monomolecular layers formed by an organic absorbing substance. P. Dubouloz and R. Rinaldi. *C.R. Acad. Sci.* [*Paris*] **238**, 2506–7 (*June* 28, 1954) *In French.*

The difference *di* of the Brewster angle for a clean surface and a surface coated with a monomolecular layer of haemin is measured for $\lambda = 7500$–3650 Å. On water *di* is constant for all films (35′ for 3650 Å). On silica the value of *di* may be near 19′, 24′ or 32′ suggesting that on different occasions the molecules may be oriented in 3 different ways on the surface. Optical densities of films on glass are also determined. G. F. LOTHIAN

535.514.2

9145. On polarization by transmission with particular reference to selenium films in the infrared. G. K. T. Conn and G. K. Eaton. *J. Opt. Soc. Amer.*, **44**, 553–7 (*July*, 1954).

The old method of polarization by transmission through a pile of plates or films inclined to the incident radiation at Brewster's angle is widely used both in the infrared and ultraviolet regions. The polarization effected is commonly estimated by an expression due to Provostaye and Desains in which it is assumed that there are multiple reflections among all the surfaces. Such an expression does not give agreement with experiment; for example, the predicted figure for eight films of selenium in the infrared is 89%, while the observed value is over 99%. The performance of such polarization units is analysed and comparison is made with observations on thin films of zaponlac in the visible and of selenium in the infrared. Multiple reflections among the component films are of little importance because of the significant intervals between the plates. Interference within the films is examined. Because the tolerance permitted to the phase difference between the interfering components is small, these phase differences are to be regarded as randomly distributed. There is, therefore, little regular interference, and the phase change introduced by such

components is negligible if the refractive index is large. Detailed expressions are derived and discussed. Calculated figures of polarization agree with experiment. A.

535.514.2

9146. The polarization of totally reflected light. R. W. Ditchburn and G. A. J. Orchard. *Proc. Phys. Soc.* [*London*] *B*, **67**, 608–14 (*Aug.*, 1954).

Describes the measurements of the state of polarization of light totally reflected at a water–air surface. The results agree with theoretical predictions. It is shown that the polarization of light totally reflected at glass–air surfaces can be significantly altered by mild polishing or etching of the surface. Changes of polarization due to the presence of a film of long-chain molecules on a water surface have been observed, and it is suggested that these changes may be used for investigating the properties of liquid films. Some improvements in a photoelectric method of measuring ellipticity are described. A.

535.514.9

9147. The polarization of light by narrow slits. R. V. Jones and J. C. S. Richards. *Proc. Roy. Soc. A*, **225**, 122–35 (*Aug.* 6, 1954).

The fraction of the incident light transmitted by various narrow slits of finite depth and with metal walls is measured for two states of polarization and two wavelengths of the incident light. It is found: (1) that real, narrow slits do not transmit all the incident light; (2) that the transmission losses increase when the depth of the slit is increased, and decrease when the conductivity (or reflectivity) of the slit walls is increased; (3) that when a slit is more than about half a wavelength wide, light polarized with its electric vector parallel to the slit is transmitted better than light polarized with its electric vector perpendicular to the slit, and that for either state of polarization the fraction of incident light transmitted increases as the wavelength is decreased; (4) that a slit less than half a wavelength wide transmits light polarized with its electric vector normal to the slit only, and that in such a slit the fraction of incident light transmitted increases as the wavelength is increased. It is shown that the existence and order of magnitude of all these effects may be predicted from the electromagnetic theory of light, and that some of them may be expected from a consideration of the older scalar wave theory. The paper includes some brief notes on the transmission of light by dielectric slits and on the diffraction patterns produced by slits of finite depth, and concludes with some applications of the observed phenomena. A.

535.515

9148. On the optical properties of components for birefringent filters. R. G. Giovanelli and J. T. Jefferies. *Austral. J. Phys.*, **7**, 254–67 (*June*, 1954).

Expressions are derived for the stray light in a birefringent filter caused by polarizers producing incomplete polarization and by inexact half-wave plates. It is shown that, with suitable orientation of retardation plates, less stray light is obtained with incomplete than with complete polarizers. The asymmetry of the field and the stray light arising from incorrect orientation of the crystal axes are also discussed. A.

535.515

9149. A new photoelectric method for the calibration of retardation plates. D. D. Randall. *J. Opt. Soc. Amer.*, **44**, 600–2 (*Aug.*, 1954).

The theory and the experimental procedure are given for a new photoelectric method of measuring any relative phase retardation in a plate. As the method is most accurate for a phase retardation of $\pi/2$, it is especially powerful for calibrating quarter-wave plates directly and half-wave plates indirectly. It is applicable to the ultraviolet, visible and near infrared regions of the spectrum, being limited only by the sensitivity of the photocells used. The wavelength at which a retardation plate is quarter or half wave can be given with an accuracy of less than 0·2%, which is equivalent in the visible range to about 10 Å. The method may be used to determine the dispersion of birefringence in a plate over the whole spectral range of the photocells. A.

535.515

9150. Birefringence of crystals in the near infrared. A. M. Vergnoux and M. Pouzol. *J. Phys. Radium*, **15**, 541–2 (*June*, 1954) *In French.*

Results of measurements on gypsum are given on curves showing the difference of the two refractive indices for $\lambda = 0{\cdot}6$–$1{\cdot}2\,\mu$ and transmissions for the two principal directions of electric vector for $\lambda = 0{\cdot}6$–$2{\cdot}1\,\mu$. G. F. LOTHIAN

535.55

9151. Photoelastic constants of ammonium dihydrogen phosphate and potassium dihydrogen phosphate. R. O'B. Carpenter. Letter in *J. Opt. Soc. Amer.*, **44**, 425 (*May*, 1954).

The constants are defined as $q_{ij} = \partial a_i/\partial T_j$, where T_j = stress, a_i = coefficients of Fresnel's index ellipsoid, and q_{ij} = stress-optic coefficient. For $NH_4H_2PO_4$ the results in brewsters are $q_{11} = 8{\cdot}6$, $q_{12} = 7{\cdot}9$, $q_{31} = 12{\cdot}3$, $q_{44} = -5{\cdot}8$, $q_{66} = -12{\cdot}2$, $q_{13} - q_{33} = -1{\cdot}6$. For KH_2PO_4, according to West and Makas [*American Mineralogist*, **35**, 130 (1949)], $q_{66} = -11{\cdot}25$ and $0 > q_{11} - q_{12} > -0{\cdot}3$. H. G. JERRARD

535.561

9152. The temperature variation of the rotatory power of quartz from 30° to 410°C. S. Chandrasekhar. *Proc. Indian Acad. Sci. A*, **39**, 290–5 (*June*, 1954).

The temperature variation has been measured from 30° to 410°C for a range of wavelengths extending from 6000 Å to 2500 Å. It is found that the temperature coefficient $\left(\frac{1}{\rho_0}\frac{\Delta\rho}{\Delta t}\right)$ exhibits an increase in the ultraviolet. The rotatory dispersion of quartz is accurately expressible from the visible to the extreme ultraviolet by a formula of the form $\rho = av^2/(v_0^2 - v^2)^2$, where $v = 1/\lambda$. Taking "a" to be invariable with temperature but v_0 to vary with it, the thermal variation of the rotatory power has been calculated over the whole range of wavelengths for the different temperatures. The theoretical calculation agrees very well with the observational data, the rate of shift of v_0 being found to be roughly the same as that estimated from the thermal variation of the refraction. It is shown that theoretically the temperature coefficient

should increase with decrease of wavelength, a fact which is confirmed by experiment. A.

535.566.2 : 541.133

9153. Polarimetric and electric study of aqueous solutions of tartaric and boric acids. A. CHARRU. *J. Phys. Radium*, **15**, 10*S*–11*S* (*April*, 1954) *In French.*

The conductivity and rotatory powers of mixtures of aqueous solutions of tartaric and boric acids have been determined for various compositions. It is probable that there are three active species in the mixed solutions. The curves of variation of conductivity and rotatory power with concentration show marked similarities. A. J. MEE

535.642

9154. Additivity of colour equations. II. P. W. TREZONA. *Proc. Phys. Soc.* [*London*] *B*, **67**, 513–22 (*July*, 1954).

Following an investigation into the validity of the law described in Pt I [Abstr. 6680 (1953)], further experiments were designed, some to extend the problem and others to attempt to elucidate the cause of the small deviations which occur. Amongst the former was an experiment involving spectrophotometry. All experimental work was performed on the Wright colorimeter. Additivity of colour equations is implicit in all colorimetric calculations. It is also of interest in relation to the visual processes. Deviations were small enough to be caused by matches differing from their "correct" value by less than a just-discriminable colour step. Some deviations were explained by a displacement within a colour step caused by a breakdown in Weber's law when applied to matching stimuli. This also explained the large deviations associated with poor discrimination. A.

535.642.1 : 513.761

9155. Invariance of insidedness in projective transformations of the Maxwell triangle. G. WYSZECKI. *J. Opt. Soc. Amer.*, **44**, 524–9 (*July*, 1954).

In general, projective transformations of a plane vary shape, spacing [D. L. MacAdam (1942)] and angles of plane figures which are uniquely defined in the affine sense corresponding to general usage. Projective transformations may also transform points inside a figure into points outside the transformation of the figure, if one considers the original and transformed figure in the affine sense. If all interior points of a figure are transformed to interior points of the transformed figure, then the transformation is said to be invariant with respect to insidedness of that figure. The purpose of this paper is to derive the condition under which the projective transformations of the Maxwell triangle are invariant with regard to insidedness. The meaning of this condition is illustrated by an example violating this condition, namely, a transformation of the C.I.E. (x, y)-diagram such that the confusion lines of the protanope and tritanope are respectively parallel to either co-ordinate axis. A.

535.65

9156. A check on the standard observer data at 4358 Å. W. HARRISON. Letter in *Brit. J. appl. Phys.*, **5**, 269–70 (*July*, 1954).

In a previous paper [Abstr. 4749 (1953)] the author used measurements on fluorescent lamps to check the standard observer data for colorimetry and found better agreement with the C.I.E. data than with Wald–Gibson–Tyndall average data. He has now used the revised data submitted to the C.I.E. in 1951 and finds these give slightly better agreement with observation than do the adopted (1931) C.I.E. data. J. W. T. WALSH

535.65 : 612.843.31

9157. A color memory test. R. W. BURNHAM AND J. R. CLARK. *J. Opt. Soc. Amer.*, **44**, 658–9 (*Aug.*, 1954).

A test of colour memory has been developed using chips from the Farnsworth–Munsell hue series. An individual is asked to select from a hue-circle of colour samples the one which most resembles a test sample presented a short time before. This procedure is repeated for a number of test samples so that the observer can be reliably scored on a basis of demonstrated accuracy. A.

535.681 : 551.593.9

Measurements of sky luminance distribution at Stockholm. *See Abstr.* 9847

535.7 : 612.84

Physiological optics. *See Abstr.* 9857–60

535.81

9158. Stray light in optical instruments. J. HARTMANN. *Optik*, **11**, *No.* 8, 351–65 (1954) *In German.*

The various origins of stray light in optical instruments are considered and their variation with lens apertures and object size described. Methods of measuring the stray light are given and sample results for typical photographic lenses are quoted. R. W. FISH

535.81

9159. A photoelectric apparatus for the production testing of photographic objectives. H. BENDER. *Optik*, **11**, *No.* 8, 388–94 (1954) *In German.*

While photographic tests are satisfactory for prototype lenses, production testing may require a more rapid method, less liable to errors due to differences in emulsion properties, development, etc. The photoelectric apparatus described uses a narrow slit to scan the rotating image of a radial test object. After amplification of the output, it is displayed on a cathode-ray tube. The radius at which the a.c. component of the output vanishes gives a measure of the resolving power, which by adjustment of the slit size may have the same numerical value as the photographic resolving power. R. W. FISH

535.81

9160. A sliderule for the approximate calculation of the number of lenses on a spherical lens holder. H. JENSEN. *Optik*, **11**, *No.* 8, 395–6 (1954) *In German.*

A sliderule is suggested for use in the optical workshop. An approximate relationship between the lens diameter, the radius of curvature of the surface to be worked, the depth of the lens holder and the number of lenses on the holder is brought into a form suitable for setting up on the four scales of a sliderule. A suggested engraving is illustrated. R. W. FISH

535.81 : 666

9161. Refractive indices of five selected optical glasses. R. E. STEPHENS AND W. S. RODNEY. *J. Res. Nat. Bur. Stand.*, **52**, 303–4 (*June*, 1954).

The refractive indices of typical samples of five optical glasses made at the National Bureau of

Standards were measured over a range of wavelengths from 0·35 to 2·32 μ. This was done in such a way that the values obtained in the visible and invisible portions of the spectrum are consistent with one another. The results are expressed for each glass by a six-constant dispersion formula. A.

535.81 : 666

9162. Spectral transmissive properties of five selected optical glasses. H. J. KEEGAN, M. A. BELKNAP AND D. J. CORDREY. *J. Res. Nat. Bur. Stand.*, **52**, 305–8 (*June*, 1954).

Measurements of the spectral transmittance and internal transmittance of five optical glasses for the wavelength region 200 to 1000 mμ are reported. A.

535.81 : 666

9163. Densities of five selected optical glasses. C. T. COLLETT. *J. Res. Nat. Bur. Stand.*, **52**, 309 (*June*, 1954).

Densities of five optical glasses were determined by the hydrostatic weighing method. Values are presented by type of glass, index of refraction and Abbe value. A.

535.81 : 666

9164. Thermal expansion of five selected optical glasses. P. HIDNERT. *J. Res. Nat. Bur. Stand.*, **52**, 311–12 (*June*, 1954).

Coefficients of linear thermal expansion of five optical glasses were determined by a strain gauge method for the range between room temperature and 60°C. The coefficients of expansion of two crown glasses are $7{\cdot}6\times10^{-6}$ per deg C. A rare-earth glass was found to have a slightly lower coefficient of expansion, but the coefficients of expansion of two flint glasses are 10% larger than the other glasses. A.

535.818.2

9165. Vignetting in visual instruments. R. C. LANE AND R. S. LONGHURST. *J. sci. Instrum.*, **31**, 288–93 (*Aug.*, 1954).

If an optical instrument designed for visual use exhibits spherical aberration of the exit pupil, shadows may appear in the field of view as the eye rotates in its socket to explore the image. A method is given for finding the variation in image luminance, allowing for the Stiles–Crawford effect. The case of scotopic vision (Stiles–Crawford effect absent) is examined in detail. An example is given of the shadows which can occur in a typical binocular telescope. A.

535.824

9166. A new series of photomicrographic lenses. J. R. BENFORD AND J. V. BUTTERFIELD. *J. Opt. Soc. Amer.*, **44**, 598–600 (*Aug.*, 1954).

Describes a new series of photomicrographic field-flattening eyepieces, designed to compensate the residual aberrations of microscope objectives, notably flatness of field and lateral colour. The systems are negative in power, and, strictly speaking, are not "eyepieces" since the pupil is internal, preventing direct visual use, but they are directly interchangeable with conventional visual eyepieces in the microscope and yield a large and well-corrected image for photomicrography and microprojection. A.

535.824.2 : 535.33.07–15

9167. A reflecting microscope for infra-red absorption measurements. K. P. NORRIS. *J. sci. Instrum.*, **31**, 284–7 (*Aug.*, 1954).

The factors affecting the design of reflecting objectives suitable for this purpose are discussed and it is shown that for use in the rock-salt region of the infrared it is possible to use a bi-spherical objective of 0·8 numerical aperture with a central obstruction of 40%. The dimensions of three satisfactory objectives are given. A.

535.84 : 771.4

9168. Procedure for the reproduction of images with amplification of contrast. P. D. LADOUCE. *J. Opt. Soc. Amer.*, **44**, 464–8 (*June*, 1954).

This procedure makes use of the principle employed in the transmission of images through distance (phototelegraphy, television) by analysing the original, dot by dot, and by reproducing it in the same manner. The original's reading circuits or those of the subsequent amplification of the electric impulses provide the means for selection in the original of a certain band of optical densities; this band will be enhanced at a maximum in the reproduction, from the white (density 0) to the black (density 3 or more). An example is given of a reproduction at great contrast obtained with the rudimentary apparatus built on this principle. The high degree of amplification of contrast which can be obtained with this procedure of quick and easy application makes it possible to show objects, details, and shapes in the reproduction unseen in the original; furthermore, it makes it possible to obtain reproductions at normal contrast of photographs and X-rays taken with a considerable reduction in the time of exposure. A.

535.89 : 771.534.5

9169. A mosaic filter daylight source for aerophotographic sensitometry in the visible and infrared region. M. R. NAGEL. *J. Opt. Soc. Amer.*, **44**, 621–4 (*Aug.*, 1954).

An unconventional filter is described which converts the light of a tungsten lamp of 2660°K colour temperature to daylight. The filter consists of 169 small Corning glass filters, each 3 by 3 mm in size and cemented, in the form of a mosaic, on a common glass base. A good approximation to natural daylight is obtained in the region between 5200 and 9000 Å which enables panchromatic and infrared sensitometry through the entire region useful in general photographic reconnaissance. The new light source is compared with a number of other sensitometric light sources. Its spectral characteristics are superior to any of the other glass filter sources investigated. A.

HEAT 536

536.2 : 536.3 : 537.39

9170. The distribution of temperature along a thin rod electrically heated *in vacuo*. II. Theoretical (continued). S. C. JAIN AND K. S. KRISHNAN. *Proc. Roy. Soc. A*, **225**, 1–7 (*Aug.* 6, 1954).

The differential equation defining the distribution

of temperature in the steady state was formulated in Pt I [Abstr. 3359 (1954)]. If the rod is not too short, a solution can be obtained by suitably combining the two particular solutions for a similar infinitely long rod heated by the same current, which is applicable over the whole length of the rod. The solution is discussed in relation to some formulae that had been proposed by Stead (1920). The solution also leads to a very useful expression for the temperature at the centre of a finite long rod as a function of its length. A.

536.2 : 536.3 : 537.39

9171. The distribution of temperature along a thin rod electrically heated *in vacuo*. III. Experimental. S. C. Jain and K. S. Krishnan. *Proc. Roy. Soc. A*, **225**, 7–18 (*Aug.* 6, 1954).

This part is concerned with a detailed experimental verification of the main results obtained theoretically in Pt I and II. Thin rods of Acheson graphite were used for this purpose, and were found very suitable. In addition to the experimental data for the temperature distribution along rods of different lengths, and heated by alternating currents of different densities, it is necessary to have data for the thermal and the electrical conductivities, and the spectral and the total emissivities of the surface, at different temperatures. These measurements were consequently made. The observed temperature variation along the rod is itself used to determine the thermal conductivity and its temperature variation. The thermal conductivity is found to decrease and tend to a constant value at high temperatures, as it should. The other physical constants are determined directly. At low temperatures the spectral emissivity is found to be much larger than the total emissivity, and they tend to approach each other at high temperatures. Further, the spectral emissivity is found to decrease rapidly with increase of wavelength, as in the case of metals. Coming back to the temperature distribution, the main results that are verified here relate to the range of validity of the logarithmic formula in the *B*-region of a long rod, the constants involved in the formula, the deviation from the formula as one moves further into the *B*-region, the effect of the temperature coefficients, the parabolic law of variation near the centre, and the nature of the deviation from the parabolic law in long and short rods as one moves further away from the centre. A.

536.2 : 536.3 : 537.39

9172. The distribution of temperature along a thin rod electrically heated *in vacuo*. IV. Many useful empirical formulae verified. S. C. Jain and K. S. Krishnan. *Proc. Roy. Soc. A*, **225**, 19–32 (*Aug.* 6, 1954).

On the basis of extensive measurements made on the distribution of temperature, and on the distribution of other physical characteristics which are known functions of the temperature, along tungsten filaments heated in vacuo, several empirical formulae have been proposed by Worthing, and they have found wide practical application. Many of these formulae are shown in the present part to follow naturally from the theoretical expressions deduced in Pt I and II, as special cases. The conditions for their validity are determined. The other formulae of Worthing are shown to be good approximations, and the degrees of their closeness to the corresponding theoretical formulae are estimated. A.

536.2 : 536.65

9173. The effect of latent heat on numerical solutions of the heat flow equation. P. H. Price and M. R. Slack. *Brit. J. appl. Phys.*, **5**, 285–7 (*Aug.*, 1954).

The stability and accuracy of finite difference solutions of the heat flow equation which involve latent heat evolution are discussed. A comparison of true and finite difference solutions is used to show how a numerical solution must be interpreted, and a dimensionless group is developed which governs the appearance of inaccuracies peculiar to numerical solutions involving a latent heat term. A.

536.2.01

9174. The lattice component of the thermal conductivity of metals and alloys. P. G. Klemens. *Austral. J. Phys.*, **7**, 57–63 (*March*, 1954).

Makinson's (1938) theory of the lattice component of the thermal conductivity of metals and alloys, when limited at low temperatures by interaction with the conduction electrons, is re-examined, and the magnitude of the lattice conductivity is related to the electronic thermal conductivity at low temperatures, thus avoiding uncertainties in the theory at high temperatures. The result depends on whether transverse lattice waves can interact with the electrons. The variation of the lattice conductivity with electron concentration is discussed, and the theory is applied to the systems copper-nickel, copper-zinc, silver-palladium and silver-cadmium. At present only the first system has been measured, and the results can be reconciled qualitatively to the theory if it is assumed that holes appear in the 3*d* band for nickel concentrations greater than 10–20%. It also appears that for copper there is direct interaction between electrons and transverse waves. Qualitative predictions are made for the other three systems. A.

536.2.01

9175. The thermal conductivity of pure metals at low temperatures according to the free electron theory. P. G. Klemens. *Austral. J. Phys.*, **7**, 64–9 (*March*, 1954).

Discusses the validity of Sondheimer's variational method [Abstr. 8687 (1950)] of solving the integral (Bloch) equation for the distribution of free electrons, interacting with lattice vibrations, in the case of thermal conduction at low temperatures. This equation is solved numerically, and it is found that the resulting thermal conductivity is about 11% larger than the value calculated by Sondheimer. A.

536.2.01 : 539.11

9176. The thermal conductivity of ionic crystals. A. Herpin. *Bull. Soc. Franç. Minéral. Crist.*, **77**, 228–35 (*Jan.–March*, 1954) *In French.*

A brief review of the methods employed in the theoretical study of such quantities as thermal expansion, the temperature dependence of elastic constants and in particular the thermal conductivity. The discussion leads early to the central concept of phonons and it is shown how collisions between phonons, which are a consequence of anharmonic

forces between atoms, provide the mechanism for the transfer of energy between thermal modes and so lead to the existence of the properties mentioned.

A. D. LE CLAIRE

536.2.01 : 537.311.1

The electrical and thermal conductivities of monovalent metals. *See Abstr.* 9236

536.2.083

9177. A method of measuring the thermal conductivity of poor conductors. L. N. CLARKE. *Austral. J. appl. Sci.*, **5**, 178–82 (*June*, 1954).

The apparatus consists of a heat source, sample and heat sink. The boundary conditions are such that the temperature V_C of the sink rises linearly with time t. The conductivity of the sample is proportional to dV_C/dt. The correction due to the specific heat of the sample is small and easily applied. The apparatus is relatively simple and provides means for controlling unwanted heat losses. A.

536.212

9178. The thermal resistances of cubic metals at intermediate temperatures. P. VAN DER LEEDEN. *Proc. K. Ned. Akad. Wetensch. B*, **57**, 317–21 (*May–June*, 1954).

It is shown that all data concerning the thermal resistances w of cubic metals at intermediate temperatures ($\Theta/10 < T < \Theta$) may be described by a unique function $w_T/w_\Theta = F(T/\Theta)$. A.

536.23 : 537.56 : 533.16

The viscosity and thermal conductivity of a completely ionized gas. *See Abstr.* 8974

536.244

9179. Heat transfer in pulsating flow. H. A. HAVEMANN AND N. N. NARAYAN RAO. Letter in *Nature* [*London*] **174**, 41 (*July* 3, 1954).

The Nusselt number of heat transfer to a pulsating flow of air, in a horizontal pipe of 1 in. internal dia., heated externally by steam, varied irregularly up to $\sim 30\%$ under different conditions of frequency, amplitude, waveform and Reynolds number of the flow. The change was negative below a certain frequency and positive above it; the critical frequency was a function of the waveform and the Reynolds number. J. S. G. THOMAS

536.25

9180. Convection from a large horizontal surface. C. H. B. PRIESTLEY. *Austral. J. Phys.*, **7**, 176–201 (*March*, 1954).

A theory is put forward for convection from a large horizontal heated surface in a semi-infinite medium, by buoyant elements which are subject to continuous mixing with the environment by turbulence on a smaller scale. It is assumed, with support from similarity arguments, that the (potential) temperature θ at sufficient height z above the surface obeys the form $-(g/\theta)(\partial\theta/\partial z) = Cz^{-\delta}$, where δ and C are positive constants. It is then shown: (i) that δ must in practice be close to 4/3 and equal to it under steady conditions, except in layers where radiational heating is large, where δ will be smaller; (ii) that the rate of heat loss varies as $C^{3/2}$; and (iii) that the r.m.s. temperature fluctuations are proportional to $Cz^{-1/3}$. Experimental results from the surface layers of atmosphere support these predictions quite well. The principal results are first suggested for free convection by dimensional and similarity arguments. They receive independent confirmation from the mechanistic theory, which extends into conditions when forced convection is present but not dominant. The theory also provides information about the multiplying constants in the above relationships, though it does not so far lead to a prediction of their exact values. The multiplying constants depend, *inter alia*, on the mass ratio between the ascending and descending air, and this remains constant through the layer of constant heat flux. The behaviour of the ascending elements and that of the descending air are shown to be quite differently governed. A.

536.25

9181. Vertical heat transfer from impressed temperature fluctuations. C. H. B. PRIESTLEY. *Austral. J. Phys.*, 7, 202–9 (*March*, 1954).

The ability of buoyant elements to carry heat upwards through a stably stratified fluid depends on their rate of mixing and hence on their size. The largest and smallest elements are both relatively ineffective and there exists an optimum intermediate size yielding a maximum value of the buoyant heat flux for a given intensity of temperature disturbance. For a layer of uniform unstable stratification the heat flux increases progressively with size of element and there is no theoretical upper limit apart from that set by the depth of the unstable layer. The distribution, with respect to element size, of the intensity of temperature fluctuations impressed by external influences is modified by the effects of buoyancy and mixing, and relations are derived between the modified and unmodified distributions. A.

536.42

9182. Melting curves of deuterium and hydrogen. P. F. CHESTER AND J. S. DUGDALE. Letter in *Phys. Rev.*, **95**, 278–9 (*July* 1, 1954).

The curves have been determined to a pressure of 2800 kg/cm^2, the previous limit for deuterium being 100 kg/cm^2. The curves remain parallel, within the experimental error, over the whole range with a mean separation of 170 kg/cm^2. F. E. HOARE

536.423.15

9183. The vapor pressure of zinc between 150° and 350°C. J. D. MCKINLEY, JR, AND J. E. VANCE. *J. chem. Phys.*, **22**, 1120–4 (*June*, 1954).

The vapour pressure of zinc has been measured by the Knudsen effusion method using the radioisotope Zn^{65}. Measurements have been made from 150° to 350°C, and the temperature/vapour-pressure relation over this range was found to be $\log_{10}P_{mm} = -7198/T + 9{\cdot}664$. The heat of vaporization was calculated to be 31·35 kcal per mole at 0°K. A test has been made of the Clausing probability factor regarding the dependence of the effusion rate on the dimensions of the effusion orifice. A.

536.423.15

9184. Calculation of the fraction of effusing molecules which strike a collector plate above a channel hole. R. D. FREEMAN AND A. W. SEARCY. Letter in *J. chem. Phys.*, **22**, 1137–8 (*June*, 1954).

A table has been constructed from Clausing's

calculations which can be used to give the fraction of molecules entering a channel (of given length/radius) which strike a circular plate subtending a given angle at the exit of the channel. Simple approximate formulae are also provided. It is shown that vapour pressure determinations using the Knudsen method may be in error by 25% because of failure to allow for the length of the channel. R. O. DAVIES

536.423.15 : 533.12

9185. The vapour pressure and orthobaric density of nitrous oxide. D. Cook. *Trans Faraday Soc.*, **49**, 716–23 (*July*, 1953).

The vapour pressure of nitrous oxide has been determined from 12°c to the critical point, and the orthobaric densities from 20°c to the critical point. The apparatus consisted of a calibrated, heavy-walled, hard-glass pressure tube containing the gas sample, confined over mercury, and thermostated with a vapour bath. Visual observation of the dew points, boiling points and critical points was thus possible. Pressures were determined with a free piston gauge to 0·01 atm and temperatures to 0·01°c with mercury-in-glass thermometers. A cathetometer capable of reading to 0·001 cm was used to make the volume measurements. The vapour pressures obtained are substantially lower than the I.C.T. values and are represented by the equation $\log_{10}p$ (atm) = 4·6258 − (858·63/T). The results are compared with other determinations on the vapour pressure and orthobaric densities of N_2O. A.

536.423.15 : 536.655

9186. Vapor pressure of uranium. E. G. Rauh and R. J. Thorn. *J. chem. Phys.*, **22**, 1414–20 (*Aug.*, 1954).

The vapour pressures and the heat of vaporization of liquid uranium have been measured by collecting a known fraction of the vapour effusing from a Knudsen cell. The deposits were "weighed" by comparing the number of fissions upon thermal neutron irradiation with the fissions from a standard. The measured rate of vaporization is extremely sensitive to the residual pressure of oxygen in the vacuum at background pressures of the order of 10^{-7} mm Hg. With the aid of a theoretically derived expression the effusion rate can be extrapolated to zero oxygen pressure to yield for the vapour pressure the result that $\log p$ (mm) = $-$ [(23330 ± 21)/T] + (8·583 ± 0·011), over the temperature range 1630 to 1970°K. This expression, together with heat capacity data for solid uranium, yields a value of 116·6 kcal/mole for heat of sublimation at 0°K and predict a value of about 4·7 kcal/mole for the heat of fusion. A.

536.46

9187. Isolation of HO_2 from the hydrogen, oxygen diffusion flame. J. D. McKinley, Jr. Letter in *J. chem. Phys.*, **22**, 1258 (*July*, 1954).

The experiments of Stadnik [*Dokl. Akad. Nauk SSSR*, **87**, 445 (1952)] were repeated and extended. No hydrogen peroxides were found but nitrous acid, formed either by impurities or from the atmosphere around the apparatus, was certainly present as an intermediate product in the hydrogen–oxygen diffusion flame. This would explain all the former evidence. As nitrous acid would destroy any peroxides present, the formation of the latter can only be investigated under exclusion of all nitrogen. A. J. TAYLOR

536.46 : 537.521.7 : 541.126

9188. Application of ideal gas theory to the gaseous expansion from an electric spark. R. B. Edmonson, H. L. Olsen and E. L. Gayhart. *J. appl. Phys.*, **25**, 1008–13 (*Aug.*, 1954).

The gaseous expansion from an electric spark is described in this paper in terms of ideal gas theory. The assumption is made that a quantity of energy is injected into a small gas volume in an infinitesimally short time and that the initial volume of gas then expands until it reaches the pre-spark pressure at an elevated temperature. Experimental results are given for a condenser discharge illustrating the dependence of the pressure equilibrated gas volume upon initial pressure and condenser energy. These results are interpreted using the ideal gas model presented. The significance of this expansion to the problem of spark ignition in combustible gases is discussed. A.

536.461

9189. The laminar flame speed of propane/air mixtures with heat extraction from the flame. J. P. Botha and D. B. Spalding. *Proc. Roy. Soc. A*, **225**, 71–96 (*Aug.* 6, 1954).

536.48

9190. On the Bose–Einstein liquid model for liquid helium. II. Properties under high pressures. Z. Mikura. *Progr. theor. Phys.*, **11**, 207–12 (*Feb.*, 1954).

For Pt I, see Abstr. 8233 (1954). The excitation energy in the "modified Bose–Einstein liquid" model is assumed to be proportional both to the number density of He^4 particles and to one-third power of the particle mass. In a previous paper, many properties of the He^3–He^4 liquid mixture were accounted for by using this model, assuming a particle mass independent of He^3 concentration. In the present paper, this model is shown to be successfully applied also to the case of pure liquid He^4 under high pressures. The values of parameters (the excitation energy and the particle mass), which are chosen so as to reproduce the correct λ-temperature corresponding to the pressure concerned, are found to be of the correct magnitude to explain the experimental pressure dependences of second sound velocity and of the entropy on the λ-curve. A noticeable fact is that the increase in the value of the particle mass due to pressure is almost exactly proportional to pressure. A.

536.48

9191. Fermi–Dirac degeneracy in liquid He^3 below 1°K. W. M. Fairbank, W. B. Ard and G. K. Walters. Letter in *Phys. Rev.*, **95**, 566–8 (*July* 15, 1954).

Previous measurements [Abstr. 1245 (1954)] of the magnetic susceptibility of He^3 are extended from 1·2 to 0·23°K. The magnetic resonance method is the same as before but application of magnetic refrigeration involves modification of the apparatus in consequence of which the spin "lattice" relaxation time is brought down to 30 from its previous value of

200 sec. The product of susceptibility and temperature is found to be almost independent of the temperature above 0·8° and to decrease markedly if the temperature is reduced. This result suggests the onset of Fermi degeneracy. The theory of the ideal Fermi gas yields, however, a temperature of degeneracy of $T_0 = 5°K$ if the actual molecular mass and density are taken into account. The calculated susceptibility is accordingly by far lower than the experimental values. Agreement can be enforced by adjusting T_0; best fit is obtained for $T_0 = 0·45°K$.

R. EISENSCHITZ

536.48

9192. The problem of liquid helium — some recent aspects. J. G. DAUNT AND R. S. SMITH. *Rev. mod. Phys.*, **26**, 172–236 (*April*, 1954).

A wide field of experimental and theoretical research is reviewed. Article is concluded in September 1953; references up to May 1954 are added. R. EISENSCHITZ

536.48 : 534.23

9193. Ultrasonic measurements in magnetically cooled helium. C. E. CHASE AND M. A. HERLIN. Letter in *Phys. Rev.*, **95**, 565–6 (*July* 15, 1954).

Absorption of "first" sound in liquid helium is measured at a frequency of 12·1 Mc/s and at temperatures between 0·1 and 1·2°K. A marked maximum of attenuation at 0·85° is accompanied by a subsidiary maximum at 1·0° approx. Appearance of two separated maxima is in accordance with the theory of Khalatnikov [Abstr. 6451 (1950), 3257 (1953)].

R. EISENSCHITZ

536.48 : 532.51 : 530.145

9194. A quantum theory for non-viscous fluids in the Lagrange variables. S. F. B. TYABJI. *Proc. Cambridge Phil. Soc.*, **50**, *Pt* 3, 449–53 (1954).

The author transforms the equations of classical hydrodynamics to the Hamiltonian form without employing the somewhat cumbersome methods of previous authors [Abstr. 6721, 6726 (1953)]. He restricts the argument to types of flow in which local displacements are small; there is no restriction to irrotational movement. Resolving in this way the flow in longitudinal and transversal waves, quantization is carried out by the conventional method. Whereas the significance of the transversal waves in classical hydrodynamics is not specified, they are interpreted in quantum hydrodynamics as rotons. R. EISENSCHITZ

536.48

9195. Second sound attenuation in liquid helium II. W. B. HANSON AND J. R. PELLAM. *Phys. Rev.*, **95**, 321–7 (*July* 15, 1954).

Second sound attenuation was measured in the hundred kilocycle per second frequency range with a continuous wave method. Measurements were carried out over the temperature interval from 1·25°K to 2·17°K. The short wavelengths employed and the absence of walls near the second sound beam caused geometrical attenuation and wall losses to be negligible compared to the actual liquid attenuation. The attenuation was found to be amplitude independent for the small amplitudes employed. The expected increase of attenuation with the square of the frequency was experimentally verified up to 0·27 Mc/s. Excellent agreement with Khalatnikov's latest theory was obtained for both the magnitude and temperature dependence of the attenuation. The attenuation was found to increase rapidly as the λ point was approached and apparently becomes infinite there. A.

536.483

9196. Magnetic cooling. C. G. B. GARRETT. *New York: John Wiley and Sons; London: Chapman and Hall* (1954) 110 pp.

A survey is made of the properties of matter below 1°K—especially those investigated since the appearance of Casimir's "Magnetism and very low temperatures"; experimental techniques are then described briefly. The thermodynamics of magnetization is treated by the method of Guggenheim. Six methods for measuring low absolute temperatures are given, with particular emphasis on the use of adiabatic susceptibility measurements in correcting the empirical T^* scale. There is a review of the theory of paramagnetism at low temperatures (given before the results of susceptibility and specific heat measurements) including the effects of electric crystalline field and nuclear hyperfine structure on the energy levels of an ion in a crystal, and also of dipolar and exchange interaction between ions. A separate chapter is devoted to co-operative effects of an antiferromagnetic character due to magnetic and exchange interaction. The book concludes with a description of experiments on helium and metals below 1°K, magnetic cooling engines, cascade demagnetization and nuclear alignment and polarization. R. O. DAVIES

536.483

9197. An efficient cryostat for producing temperatures between 4° and 80°K: the production of liquid hydrogen targets using liquid helium. C. A. SWENSON AND R. H. STAHL. *Rev. sci. Instrum.*, **25**, 608–11 (*June*, 1954).

The cooling of apparatus using liquid helium can be made a much more efficient process if the total heat content of the evaporating gas is used in addition to the latent heat of vaporization of the liquid. Two cryostats for use on very different problems which make use of this principle are described. The first cryostat was used to maintain temperatures between 4° and 80°K in an application with very high heat influxes. The second cryostat, made necessary by restrictions on the manufacture of liquid hydrogen, used liquid helium both to condense a liquid hydrogen cyclotron target, and to maintain the target at temperatures near 20°K. A.

536.5.081 : 536.44

9198. The triple point temperature of nitrogen trifluoride (66·37°K) as a possible fixed point. L. PIERCE AND E. L. PACE. Letter in *J. chem. Phys.*, **22**, 1271 (*July*, 1954).

Two determinations show that NF_3 melts very sharply (0·001–0·003 deg. melting range). The triple point may therefore form a suitable fixed point below 90°K. R. O. DAVIES

536.5.081.3

9199. Absolute temperature scale between 4·2° and 5·2°K. R. BERMAN AND C. A. SWENSON. *Phys. Rev.*, **95**, 311–14 (*July* 15, 1954).

The vapour pressure of helium has been determined between 4·25° and 5·1°K, using a constant

volume gas thermometer. An equation is proposed which fits the experimental data closely, and gives temperatures which differ by a maximum of 0·02° from the currently accepted values. The reliability of the value of the boiling point of helium and the thermodynamic consistency of the properties of liquid helium near the boiling point are discussed. A.

536.521

9200. A surface-scanning pyrometer. R. B. Sims and A. Place. *J. sci. Instrum.*, **31**, 293–4 (*Aug.*, 1954).

A description is given of a laboratory prototype of a pyrometer, designed to measure at high speed the distribution of temperature over a heated body which cannot be approached sufficiently closely to use contact methods. The instrument has been calibrated against a uniformly heated surface and the brightness temperature may be measured to within ± 4° at 1400°K. The relationship between the current in the photomultiplier cell, used as detector, and temperature is linear, and not dependent on the inverse temperature as for ordinary vacuum photocells. A.

536.521 : 536.462

9201. Determination of transient flame temperatures. G. W. Bauserman, C. H. Prien and T. Zandstra. *Rev. sci. Instrum.*, **25**, 640–3 (*July*, 1954).

A description is given of an instrument to determine the temperatures of rapidly varying flames. This instrument uses a photoelectric modification of the line-reversal method, wherein the light beam from a temperature-variable incandescent source is split into two monochromatic beams by means of mirrors and filters to impinge upon 931A photo-multiplier tubes. The phototube signals are sent to a μ-bridge null detector, whose output is fed to an oscilloscope for photography of results. The instrument can detect 25°K temperature differences between about 1540° and 3100°K and three msec time differences. Typical time-temperature results are given, along with the analytical procedures used. A.

536.521 : 536.462 : 535.338.35

9202. Determination of combustion temperatures by optical methods. A. Moutet. *Rev. Opt.*, **33**, 313–38 (*July*, 1954) *In French.*

Optical methods of measuring flame temperatures are reviewed and the line reversal process is described in detail. An apparatus based on this principle has been designed and constructed, specially for rocket jets, but also generally applicable to flame temperature measurement. Three models are described; they are capable of giving readings up to a rate of 4500 per second. A.

536.531 : 537.3

9203. The measurement of the absolute temperature of a metallic conductor from the electrical tension produced by the thermal agitation of the electrons in the conductor. R. Aumont, J. Romand and B. Vodar. *C.R. Acad. Sci.* [*Paris*] **238**, 1293–6 (*March* 22, 1954) *In French.*

The thermal noise of two known resistances, one of which is at a known temperature, is compared using the same pass band amplifiers, detectors, etc. For a 2000 Ω Nichrome resistance an accuracy of 1°K at 780°K (measured with a Pt–PtRh thermocouple) is obtained. See also Abstr. 2425 (1950).

F. ANSBACHER

536.532

9204. Multirange, audiofrequency thermocouple instruments of high accuracy. F. L. Hermach and E. S. Williams. *J. Res. Nat. Bur. Stand.*, **52**, 227–34 (*May*, 1954).

Two new types of thermocouple instruments developed at the National Bureau of Standards are described. The first, called a volt-ampere converter, is used with a d.c. potentiometer to make measurements of a.c. voltage and current over wide ranges with an accuracy of 0·05% at frequencies up to 20 kc/s. The second is a 0·5% multirange thermocouple voltammeter incorporating simple circuits so that the thermal converter may be checked with the indicating instrument normally connected to it. A.

536.581 : 548.733

A precision micro-thermostat for crystal X-ray studies. *See Abstr.* 9766

536.62

9205. An adiabatic apparatus for the study of self-heating of poorly conducting materials. W. H. Raskin and A. F. Robertson. *Rev. sci. Instrum.*, **25**, 541–4 (*June*, 1954).

A small automatic furnace has been designed for the study of the thermal decomposition of wood and other combustible materials. After a sample has been brought nearly to thermal equilibrium at any desired temperature, the furnace temperature control system is automatically changed to allow the sample to self-heat up to a temperature of 500°C with small external heat loss or gain. Weight changes of the specimen during the test are continuously monitored amd recorded. The control system is designed to stop the operation automatically after the specimen temperature has increased to some previously selected level. A.

536.62 : 539.16

9206. Calibration of a micro-calorimeter by means of a radioactive substance of constant thermal output. P. Boivinet and E. Calvet. *C.R. Acad. Sci.* [*Paris*] **238**, 1995–7 (*May* 17, 1954) *In French.*

Discusses briefly the limitations of method using Joule heat and describes the use of a radioactive source. L. G. CARPENTER

536.631

9207. A method of automatic measurement of specific heat. T. Hirone, S. Maeda, I. Tsubokawa and N. Tsuya. *Sci. Rep. Res. Insts Tôhoku Univ. A*, **5**, 513–19 (*Dec.*, 1953).

An automatic recording apparatus for measuring specific heat of alloys and compounds was constructed. The specific heat could be computed from the recorded chart of the electric current of the feedback circuits for controlling the energy supply together with its rate of temperature rises of the samples under test. This apparatus has been used effectively for thermal analysis of various kinds of ferromagnetic compounds and binary superlattice alloys. A.

536.631

9208. On a new method of measuring specific heat of metals. S. NISHIOKA. *Mem. Coll. Sci. Univ. Kyoto A*, **27**, 31–4 (*April*, 1953).

The direct heating method of measuring the true specific heat of metals has been improved. The details of apparatus and experimental procedure are given. The accuracy of the present method is shown in detail with the experimental data for copper. The advantages of the present method lie in the considerable precision and speediness. A.

536.631 : 536.48

9209. The molar heats of lead sulphide, selenide and telluride in the temperature range 20°K to 260°K. D. H. PARKINSON AND J. E. QUARRINGTON. *Proc. Phys. Soc.* [*London*] *A*, **67**, 569–79 (*July*, 1954).

An apparatus suitable for calorimetry at low temperatures is described. With it, the molar heats of lead sulphide, selenide and telluride have been measured between 20°K and 260°K. These salts show a normal family of molar heat curves, from which the usual thermodynamic functions have been calculated. An analysis of corrections required, with the method of calorimetry used, is given in an Appendix. A.

536.631 : 536.48

9210. The specific heat of graphite below 90°K. U. BERGENLID, R. W. HILL, F. J. WEBB AND J. WILKS. *Phil. Mag.*, **45**, 851–4 (*Aug.*, 1954).

Values are given of the specific heat of graphite between 1·5°K and 90°K. Below about 12° the specific heat varies with temperature as $T^{2\cdot4}$; this is inconsistent with the work of several authors who, on theoretical grounds, have predicted a T^2 temperature dependence. A.

536.631 : 538.222

Paramagnetic and thermal study of the Heusler alloy $MnSnCu_2$. *See Abstr.* 9392

536.631 : 548.7

Frequency spectrum and specific heat of a face-centered cubic lattice. *See Abstr.* 9746

536.632

9211. Determination of true specific heats. Case of liquids of high vapour pressure. J. BROUTY AND E. CALVET. *C.R. Acad. Sci.* [*Paris*] **238**, 1879–81 (*May* 10, 1954) *In French.*

Describes a technique of microcalorimetry, using differential calorimeters. Water is used for direct calibration. Correction is made for the changing amount of the substance in the vapour phase in the case of liquids of high vapour pressure.

L. G. CARPENTER

THERMODYNAMICS 536.7/.8

536.7

9212. The variational theory of irreversible phenomena. I. PRIGOGINE. *Bull. Acad. Roy. Belgique Cl. Sci.*, **40**, *No.* 5, 471–83 (1954) *In French.*

The equations for the evolution in time of irreversible processes are written in a variational form in some important cases (thermal conductibility, chemical reactions). The stationary non-equilibrium states are shown to be characterized by a minimum of a quadratic function of the velocities or rates of the irreversible processes. In the neighbourhood of equilibrium, this function reduces to the entropy production per unit time in accordance with a theorem derived previously by the author. The variational principle introduced here which may be called "the principle of the least velocities," plays a role somewhat similar to the Gauss principle of the "least constraints" in classical mechanics. A.

536.7

9213. *H*-theorem of Boltzmann. Lodschmidt paradox. L. SARTE. *J. Phys. Radium*, **15**, 3 *S*–5 *S* (*April*, 1954) *In French.*

The Boltzmann theorem cannot be used as a law covering the energy dissipation of the universe, but another, much more satisfactory, hypothesis can be found. The statistical laws of nature are symmetrical in time, there is no discrimination between evolution towards the future or the past. C. TURNER

536.7

9214. Thermodynamic functions for carbon dioxide in the ideal gas state. H. W. WOOLLEY. *J. Res. Nat. Bur. Stand.*, **52**, 289–92 (*June*, 1954).

The thermodynamic functions C_p°/R, $(H^\circ - E_0^\circ)/RT$, $-(F^\circ - E_0^\circ)/RT$, and S°/R for carbon dioxide in the ideal gas state are given from 50° to 5000°K, based on the latest spectroscopic data. A.

536.7 : 539.11

9215. Isotope effects and thermodynamic properties in condensed phase. I. I. PRIGOGINE, R. BINGEN AND J. JEENER. *Physica*, **20**, 383–94 (*July*, 1954) *In French.*

The zero-point energy of solid isotopic mixtures is discussed and their properties are compared with those of the pure isotopes. The case of a one-dimensional chain of molecules is considered in some detail because the calculations may then be performed in a rigorous way. An extension of the results to real three-dimensional crystals will be worked out in a subsequent paper. Only harmonic oscillators are considered. It is shown that the zero-point energy increases steadily with the number of couples of first neighbours between molecules of different masses. The zero-point energy is lowest for the pure isotopes and highest for the ordered lattice ABAB..... Also its value for a random distribution of the isotopes is higher than that for the pure isotopes. The stable state at 0°K always requires a separation into pure isotopes. Differences in masses, i.e. isotopic effects, may give positive deviations from Raoult's law without any effect of the statistics. The results obtained indicate the possibility of pure quantum transitions in the phase diagram due to isotopic effects at sufficiently low temperatures. These transitions are quantum analogues of order-disorder transitions. The differences in the zero-point energies due to different spatial distributions of the isotopes are small, however, so that these effects can only appear at extremely low temperatures. They are much smaller than the effects calculated by Prigogine and Philippot which are related to volume changes on mixing and thus to the anharmonicity of the motion of the molecules. A.

536.7

9216. The influence of zero-point energy on the thermodynamic properties of the low boiling point elements. J. S. DUGDALE AND D. K. C. MACDONALD. *Phil. Mag.*, **45**, 811–17 (*Aug.*, 1954).

The internal energy and molar volume at absolute zero and the characteristic temperature of the inert gas solids, together with solid hydrogen and deuterium, are calculated taking account of zero-point energy. It is found that to a good approximation a law of corresponding states is valid and the consequences of this are discussed. A.

536.7 : 539.13

9217. Contributions of vibrational anharmonicity and rotation-vibration interaction to thermodynamic functions. R. E. PENNINGTON AND K. A. KOBE. *J. chem. Phys.*, **22**, 1442–7 (*Aug.*, 1954).

Certain correction terms applying to the rigid-rotator harmonic-oscillator approximation for the thermodynamic functions have been worked out in a general form. Tables of the functions which appear in these correction terms are presented. These results have been applied in the calculation of the thermodynamic properties of nitrous oxide. A comparison of the present procedure and that of Mayer and Mayer for diatomic molecules is given. A.

536.7 : 530.162

Theory of reciprocal relations between irreversible processes. *See Abstr.* 8936

536.7 : 530.162

On the statistical mechanics of mixtures. *See Abstr.* 8937

536.7 : 539.132 : 535.375.5 : 535.343.31/.4

Calculated thermodynamic properties of ethyl chloride and 1, 1-dichloroethane. *See Abstr.* 9099

536.71

9218. The stability of SiO solid and gas. L. BREWER AND R. K. EDWARDS. *J. phys. Chem.*, **58**, 351–8 (*April*, 1954).

The available data have been critically reviewed and experiments designed to clarify the behaviour of SiO. The conclusions reached may be summarized as follows: A mixture of Si and SiO_2 will vaporize to form pure SiO gas which has a ΔH°_{298} of formation of $-21\,411 \pm 570$ cal or a dissociation energy to the gaseous atomic elements of $169\,300 \pm 3100$ cal. SiO_2 vaporizes under neutral conditions predominately to SiO and O_2 gases. Solid SiO may be prepared in a metastable amorphous or poorly crystallized form by condensation of SiO gas upon a cold surface. The most characteristic property of this solid, useful in its identification, is an electron or X-ray diffraction ring corresponding to a *d*-spacing of $3{\cdot}60 \pm 0{\cdot}05$ Å. SiO is found to be optically isotropic and X-ray data indicate a cubic symmetry for the better crystallized samples. This solid is completely soluble in HF and is believed to have an average heat capacity at constant pressure of $9{\cdot}19 \pm 0{\cdot}16$ cal/deg/mole in the region of 338°K. The metastable SiO solid prepared by quenching of SiO gas begins to disproportionate to Si and SiO_2 at an appreciable rate at around 400–700°. SiO solid appears to be thermodynamically unstable at all temperatures below 1450°K. Experimental evidence is offered which indicates that at some higher temperature SiO solid becomes stable with respect to Si and SiO_2 and has a melting point higher than 1975°K. A.

536.71

9219. *PVT* relations of liquid carbon tetrachloride and *n*-perfluoroheptane and a test of the Clausius–Mosotti equation. B. J. ALDER, E. W. HAYCOCK, J. H. HILDEBRAND AND H. WATTS. *J. chem. Phys.*, **22**, 1060–1 (*June*, 1954).

Values of $(\partial P/\partial T)_v$ for CCl_4 and *n*-C_7F_{16} have been measured over a range of approximately 20° and 160 atmospheres. The linear relation between P and T found in earlier studies to hold over 20 atmospheres for a number of liquids and solutions is here confirmed over the much larger range. One corollary is that $(\partial c_v/\partial v)_T = 0$; another is that the isothermal compressibility of C_7F_{16}, not hitherto known, is $2{\cdot}38 \times 10^{-4}$ atmosphere^{-1} at 25° and 1 atmosphere, and could easily be calculated for other temperatures. The terms in the equation $(\partial E/\partial v)_T = T(\partial P/\partial T)_v - P$ are given, also the function $v^2(\partial E/\partial v)_T$, shown in the earlier studies to be constant. Its value for CCl_4 confirms the earlier studies, for *n*-C_7F_{16} it is 101·5 atmospheres × litres^2. The dielectric constant of *n*-C_7F_{16} has been measured at 16·0° and at 38·4°, and over a pressure range of 115 atmospheres. The values obtained conform closely to the Clausius–Mosotti equation, giving a molar polarization of 49·1 cc. A.

536.71

9220. High temperature equation of state by a perturbation method. I. Nonpolar gases. R. W. ZWANZIG. *J. chem. Phys.*, **22**, 1420–6 (*Aug.*, 1954).

A theoretical study is made of the equations of state of argon and nitrogen, at high temperatures and densities. The intermolecular potential used is of the Lennard-Jones form, with an adjustable rigid sphere cut-off. A perturbation theory is developed, by which the thermodynamic properties of one system may be related to those of a slightly different system and to the difference in the intermolecular potentials of the two systems. In this article, the unperturbed system is a rigid sphere fluid, and the Lennard-Jones potential is the perturbation. The results are in fair agreement with experiment, and also lead to an experimental test of the theoretical rigid sphere equation of state. A.

536.71 : 533.7

9221. Non-equilibrium thermodynamics of thermal transpiration of a dissociating gas. R. P. RASTOGI AND R. C. SRIVASTAVA. Note in *Proc. Phys. Soc.* [*London*] *A*, **67**, 639–40 (*July*, 1954).

A mathematical derivation, using the method of thermodynamics of irreversible processes, for the affinity in either chamber of the problem considered by B. N. Srivastava [*Proc. Roy. Soc. A*, **175**, 474–83 (*July* 18, 1940)]. For a mixture of perfect gases and binary dissociation an expression is obtained from which, using the observed pressures, temperature and concentration differences, the values of the affinities may be calculated. S. WEINTROUB

536.71 : 541.11/.12

9222. The critical point and the phase rule. J. VAN DRANEN. Letter in *J. chem. Phys.*, **22**, 1265–6 (*July*, 1954).

It is argued that it is better to consider the critical state of a substance as a state of a one-phase system having (therefore) two degrees of freedom. It is pointed out that in applying van der Waals' theory to a system being discussed from the point of view of Gibbs's phase rule exact thermodynamics are being mixed up with semi-empirical theory [Abstr. 2388 (1954)]. W. GOOD

536.75 : 541.124

The production of entropy in chemical reactions. *See Abstr.* 9694

ELECTRICITY 537

THEORY . ELECTRONS 537.1

537.12 : 532.51 : 538.3

9223. On the properties of a gas of charged particles. J. LINDHARD. *K. Danske Vidensk. Selsk., mat-fys. Medd.*, **28**, *No.* 8, 57 *pp.* (1954).

Treats the behaviour of a gas of charged particles, preferably a degenerate gas. It is pointed out that the dynamic properties of this system are contained in equations for the electromagnetic field merely, of type of Maxwell's equations in matter. By the field is meant, classically, the field induced by and acting on external, classical charges. A systematic treatment on this basis implies great simplifications in the theory. The interpretation of general field equations is discussed, and the manner in which they account for absorption processes. The dielectric constants, defining linear field equations, are computed in a number of cases, to first and higher order in e^2, using both classical and quantum description of the particle motion. As a demonstration of the method is treated energy dissipation by a charged particle moving through the system, and its self-energy. Further discussion is on self-consistent field equations, and the improved electronic equations of motion. A.

ELECTROSTATICS . DIELECTRICS 537.2

537.21 : 538.12

9224. Electrostatics and magnetics. E. DURAND. *Paris: Masson et Cie* (1953), xii + 774 *pp. In French.*

Review in *Proc. Phys. Soc.* [*London*] *B*, **67**, 591–3 (*July*, 1954).

537.222 : 541.135.5

Static space-charge effects in the diffuse double layer. *See Abstr.* 9706

537.226 : 537.227 : 548.7

9225. "Seignette" electric materials. Y. LE CORRE. *Bull. Soc. Franç. Minéral Crist.*, **77**, 293–301 (*Jan.–March*, 1954) *In French.*

The ferroelectric and piezoelectric properties are discussed in relation to the crystal structure of these materials; applications are discussed. J. H. MASON

537.226.1.08

9226. A simple method for determining physical constants (ϵ, μ, σ, $tg\delta$) of small volumes of solid, liquid, and gaseous substances. A. ESAU and D. PRÖSDORF. Note in *Naturwissenschaften*, **41**, *No.* 9, 208 (1954) *In German.*

Rapid, accurate, dielectric measurements at cm wavelengths are made using a test cell of 1 cm^3 capacity inserted in a coaxial line system or waveguide. Magnetic measurements can be made on films exceeding 1 μ thickness evaporated on polystyrene plates. J. H. MASON

537.226.1.08

9227. Microwave dielectric measurements: I. 2,700 to 3,300 Mc/s range. S. S. SRIVASTAVA, C. S. RANGAN AND Y. L. KHATTAR. *J. sci. industr. Res.*, **13B**, 225–32 (*April*, 1954).

Microwave equipment has been developed to measure dielectric constant and dielectric loss of solid and liquid samples in the frequency range of 2700 to 3300 Mc/s. E_{010} cylindrical resonators and a heterodyne frequency meter have been assembled to measure relative permittivity within an accuracy of $\pm 1{\cdot}5\%$ and tan δ within $\pm 3\%$. A Q-factor of 76% of the theoretical value for the cavity is reported. Measurements on several dielectrics have been carried out to assess the performance of the equipment. A.

537.226.2

9228. A study on the dielectric spectra of ethylene glycol. H. YAMAMURA, H. NEGITA AND Y. KIKUCHI. *J. Sci. Hiroshima Univ. A*, **17**, 263–7 (*Dec.*, 1953).

537.226.2

9229. Dielectric properties of some symmetric mono-ketones at room temperature. J. L. FARRANDS. *Trans Faraday Soc.*, **50**, 493–501 (*May*, 1954).

Measurements of the relative permittivity and loss tangent of a number of ketones have been made at frequencies ranging from 100 c/s to 68 000 Mc/s (wavelength 4·4 mm). The relative permittivities are independent of frequency within this range but show a linear variation with the chain-length of the ketone. This is inconsistent with Szigeti's theoretical predictions and a tentative hypothesis to explain this behaviour is put forward. The loss tangent increases for frequencies above 10 000 Mc/s and appears to have a maximum at about 60 000 Mc/s (wavelength 5 mm). A.

537.226.2 : 621.3.011.5 : 621.315.615.2

9230. Dielectric behaviour of ethyl chloride in 3 cm region. P. SWARUP. *J. sci. industr. Res.*, **13B**, 311–13 (*May*, 1954).

The absorption coefficient and the electric susceptibility of EtCl vapour have been studied at moderate pressure in the 3 cm microwave region. The absorption coefficient is measured by utilizing a fixed frequency spectrograph with a 10 ft absorption cell. The electric susceptibility is measured by utilizing the standing-wave technique. The values of the dielectric loss factor have been calculated from the absorption coefficient values. The com-

plex permittivity of EtCl at 9000 Mc/s was $1{\cdot}011 - i(0{\cdot}000398)$. A.

537.226.2 : 548.7

Kinetic properties of the domains in Rochelle salt. *See Abstr.* 9758

537.226.2 : 548.7

Domain formation and domain wall motions in ferroelectric $BaTiO_3$ single crystals. *See Abstr.* 9759

537.226.33 : 539.389.3

9231. Electrically and elastically active relaxation modes. Y. Haven and J. H. van Santen. Letter in *J. chem. Phys.*, **22**, 1146–7 (*June* 1, 1954).

The selection rules for causing relaxation of ions between equivalent potential wells by electric fields and by elastic stresses are discussed in terms of group theory and the symmetry of the well distribution and of the relaxing agent. D. H. WHIFFEN

537.226.8 : 621.3.015.5 : 621.315.612.6

9232. The impulse breakdown strength of Pyrex glass. J. Vermeer. *Physica*, **20**, 313–26 (*June*, 1954).

The electric strength of Pyrex glass was measured at temperatures between −50°C and +100°C, using approximately linearly rising impulse voltages of durations between 30 sec and 1×10^{-5} sec. The values of electric strength obtained from successive comparable measurements were within $\pm2\frac{1}{2}\%$ of each other, which is within the limits of the known error. The high degree of reproducibility obtained is attributed to cleaning the surface of the glass before applying electrodes. At the lowest temperature (−50°C) the electric strength was independent of impulse duration between 1×10^{-5} sec and 1·0 sec and amounted to 9·2 MV/cm. With the shortest impulse (1×10^{-5} sec) the electric strength was independent of temperature between −50°C and +100°C and its value was also 9·2 MV/cm. Above −50°C and with impulses of duration $>1\times10^{-5}$ sec the electric strength was less than the above value and decreased with both increasing temperature and increasing impulse duration. The constant value of 9·2 MV/cm is very probably the intrinsic electric strength of Pyrex glass. This value was not influenced by the choice of electrode material. The lower values obtained are attributed to space-charge distortion of the electric field, caused by the accumulation of ions near to the electrodes. A.

537.228.1

9233. Piezoelectric properties of lead zirconate—lead titanate solid-solution ceramics. B. Jaffe, R. S. Roth and S. Marzullo. Letter in *J. appl. Phys.*, **25**, 809–10 (*June*, 1954).

The useful piezoelectric properties of ceramic $BaTiO_3$ have stimulated a search for other ferroelectrics suitable for fabricating piezoelectric ceramics. Solid solutions of $PbTiO_3$ and $PbZrO_3$ offer interesting possibilities and measurements of the dependence of their electromechanical properties on composition are described. A solid solution having the composition $Pb(Zr_{0\cdot55}Ti_{0\cdot45})O_3$ can withstand intermittent service at 200°C with very little degradation. Some of its electromechanical properties at room temperature are described for the unpolarized and polarized state. H. J. H. STARKS

ELECTRIC CONDUCTION . CURRENTS 537.3

537.31 : 538.565 : 621.385.83

9234. A theorem concerning noise in electron streams. J. R. Pierce. *J. appl. Phys.*, **25**, 931–2 (*Aug.*, 1954).

It is proposed that if I_{max} and I_{min} are the maximum and minimum noise currents in a noise standing wave on an electron stream, then the product of their magnitudes cannot be smaller than $|I_{max}|\,|I_{min}| = \alpha e I_0 B(\omega/\omega_q)(kT_c/eV_0)$. Various assumptions lead to a factor α ranging between 0·8 and 1. I_0 is beam current, B is band width, ω is frequency, ω_q is effective plasma frequency, T_c is cathode temperature, and V_0 is the voltage specifying the velocity of the electrons. A.

537.311.1

9235. Polarization effects in the ionic conductivity of silver bromide. R. J. Friauf. *J. chem. Phys.*, **22**, 1329–38 (*Aug.*, 1954).

Alternating current impedance measurements on samples of silver bromide with silver and with gold electrodes show the presence of polarization effects. These effects appear as a capacitive component of the impedance and a slight dependence of the resistance on the frequency of the measurement, and their dependence on temperature, frequency, pressure, voltage and impurity content has been investigated. A macroscopic theory is developed to describe the motion of the mobile charge carriers (ionic defects) which exist in AgBr at elevated temperatures. The general equations contain the effects of conduction and diffusion currents, space charge, and formation and recombination. Since these equations are non-linear, an approximation procedure is developed, which is valid for small values of the applied voltage. The results of the theory with appropriate boundary conditions give semiquantitative agreement with the temperature and frequency dependence of the observed results and afford a good qualitative description of all of the observed effects. It is concluded that Frenkel defects are responsible for the polarization effects and that the formation and recombination rate is smaller than might at first be expected. A.

537.311.1 : 536.2.01

9236. The electrical and thermal conductivities of monovalent metals. P. G. Klemens. *Austral. J. Phys.*, **7**, 70–6 (*March*, 1954).

The experimentally determined values of the high- and low-temperature electrical and thermal conductivities of pure sodium, copper, silver and gold are such that the ratios of these quantities for each of these metals do not agree with the values expected from the Bloch free-electron theory, except for the high-temperature Wiedemann–Franz ratio. Reasonable agreement can be achieved by assuming (i) that the conduction electrons can interact directly with transverse lattice vibrations; and (ii) that the Fermi surface departs significantly from spherical shape in all these metals, and touches the boundary of the Brillouin zone in the case of copper, silver and gold. A.

537.311.31 : 539.11

9237. Electrical conductivity of solid and molten copper/tin alloys. G. DARMOIS. *C.R. Acad. Sci. [Paris]* **238**, 2230–2 (*June* 9, 1954) *In French.*

Previous suggestions concerning definite compositions for Cu–Al and Cu–Zn alloys [Abstr. 6789, 7817 (1953)] and the associated theory are supported by an analysis of results in the literature on Cu–Sn. The minima of the conductivity *v.* composition curves correspond to Cu_4Sn and Cu_3Sn_2. C. A. HOGARTH

537.311.32 : 539.13

9238. Molecular structure and related problems. The conduction of electricity through solid alcohols as a result of proton transfer and molecular rotation. Y. KAKIUCHI. *Monogr. Res. Inst. Appl. Elect., Hokkaido Univ., No.* 4, 75–93 (1954).

The mechanism of electric conduction through normal solid alcohols as the result of proton transfer and molecular rotation was closely examined with especial references to the results of the experiments conducted by the author and his collaborators in recent years. It was revealed that the mechanism in this case was essentially the same with that of the conduction of hydrogen ion through liquid water proposed by Grotthuss, Bernal and Fowler, which may well be called the "proton-transfer-and-molecular-rotation" mechanism. The plausibility of this mechanism is also discussed in some detail. A.

537.311.33

9239. On a one-dimensional model of the semiconducting compounds of the type $A_{III}B_V$. B. SERAPHIN. *Z. Naturforsch.*, **9a**, 450–6 (*May*, 1954) *In German.*

Outlines a wave-mechanical treatment for the determination of the band structures for the zinc-blende lattice based on a one-dimensional potential model. C. A. HOGARTH

537.311.33

9240. The electrical properties of some complex compounds. I. P. E. FIELDING. *J. chem. Phys.*, **22**, 1153–5 (*July*, 1954).

Electrical measurements on dicobalt decamine-μ-peroxy complex (Vortmann's salt) are described. The current formulation contained Co^{III} and Co^{IV} in crystallographically equivalent positions and hence it was thought that the complex might be an intrinsic semiconductor. An apparent dielectric constant K of 10^6 was found to be due to chemical polarization caused by traces of acid on the material. It is concluded on the basis of conductivity measurements that the material is not an intrinsic semiconductor. A.

537.311.33

9241. The electrical properties of some complex compounds. II. P. E. FIELDING AND D. P. MELLOR. *J. chem. Phys.*, **22**, 1155–6 (*July*, 1954).

The possibility of several complex compounds being intrinsic semiconductors is discussed in the light of experimental work presented in this paper and in Pt I. It is concluded that complexes containing metal atoms in different oxidation states in crystallographically equivalent positions are capable of acting as intrinsic semiconductors. Additional support is given to the alternative structure of Vortmann's salt proposed by Brimn. A.

537.311.33 : 621.3.011.22

9242. The electrical resistance of pure aluminium oxide sintered in high vacuum. K. HELDT AND G. HAASE. *Z. angew. Phys.*, **6**, *No.* 4, 157–60 (1954) *In German.*

The lightly-pressed 6 mm dia. rod specimen was sintered at 1800°C for 30 min in a vacuum of 10^{-5} torr. Curves of log resistivity *v.* (abs. temp.)$^{-1}$ are shown for a high-purity and for two technically pure specimens, over the range 10^4–10^{12} Ω cm and 1500–400°C, measured in vacuum. The derived activation energy for the high-purity material is 2·38 eV below 800°C and 2·50 eV above 800°C, the other materials also tending towards 2·50 eV at high temperature, but showing much lower values at low temperature. Large variations in resistivity, probably due to H_2O absorption, were found in measurements in atmospheric air. F. F. ROBERTS (R)

537.311.33

9243. Temperature dependency of the surface recombination velocity in germanium. Y. KANAI. Note in *J. Phys. Soc. Japan*, **9**, 292–3 (*March–April*, 1954).

Measurement of the Suhl effect for CP-4 etched *n*-type Ge from -30°C to $+60$°C. The surface recombination velocity s decreased with increasing temperature from 4000 cm/sec to 60 cm/sec over this range and a log s *v.* $1/T$ plot gave a value of 0·35 eV for the depth of the surface trap, using Brattain and Bardeen's (1953) formula.

C. A. HOGARTH

537.311.33

9244. Oxygen and the surface energy-level structure on germanium. E. N. CLARKE. Letter in *Phys. Rev.*, **95**, 284–5 (*July* 1, 1954).

Heating a thin crystal of *n*-type Ge in vacuum is shown, by conductivity measurements and oxygen treatments, to have removed acceptor levels resulting from the presence of oxygen. These levels act as electron traps. If Ge with a wide surface inversion layer reacts with oxygen the conductivity will increase rather than decrease with the electrons entering the oxygen levels from the valency band, leaving mobile holes behind. C. A. HOGARTH

537.311.33 : 538.63

9245. Analysis of magnetoresistance and Hall coefficient in *p*-type indium–antimonide and *p*-type germanium. T. C. HARMAN, R. K. WILLARDSON AND A. C. BEER. *Phys. Rev.*, **95**, 699–702 (*Aug.* 1, 1954).

Existing theory on the variation of resistivity and Hall coefficient with magnetic field in semiconductors has been extended to the case of arbitrary concentrations of the electrons and holes. Equations are developed for the magnetoresistance $\Delta\rho/\rho_H$ and the Hall coefficient R_H, as functions of parameters such as temperature, magnetic-field, strength and impurity concentration. For *p*-type InSb, theory and experiment are in agreement on the following observations: (1) a shift to higher temperatures of the Hall coefficient crossover, magnetoresistance maxima, and Hall coefficient maxima with increasing magnetic field, (2) a

decrease in magnitude of the Hall coefficient maxima with increasing magnetic field, (3) the occurrence of the largest effects in the transition region between extrinsic and intrinsic conductivity, (4) magnetoresistance maxima occurring at about the same temperature as Hall coefficient maxima. For *p*-type germanium, however, the effects are not even qualitatively explained. The observed magnetic-field dependence of the Hall coefficient in the temperature region of the crossover is opposite to that predicted by the theory. Furthermore, no magnetoresistance maximum has been observed in the temperature region of the Hall coefficient maximum. Hence, it appears that a basic revision of existing treatments of *p*-type germanium is necessary. A.

537.311.33

9246. Steady-state solution of the two-dimensional diffusion equation for transistors. J. S. SCHAFFNER AND J. J. SURAN. *J. appl. Phys.*, **25**, 863–7 (*July*, 1954).

The diffusion equation is solved for transistors for (*a*) linear flow of minority carriers and (*b*) non-uniform flow of minority carriers due to a metal contact applied to the base region. The current transport ratio β is calculated for both of these cases as a function of frequency. Frequency response characteristics of a transistor, as predicted by the one-dimensional diffusion equation, give excellent results for junction transistors having base length-to-base width ratios greater than ten and having negligible surface recombination rates. For transistors where these conditions are not applicable, the two-dimensional diffusion equation must be used in the calculation of β. A.

537.311.33

9247. Hysteresis phenomena at rectifying contacts and in thin films. N. NIFONTOFF. *C.R. Acad. Sci.* [*Paris*] **239**, 31–3 (*July* 5, 1954) *In French.*

Hysteresis phenomena occurring in the current-voltage relationships of some rectifying contacts, and in some thin films of Al, Si or C, are described. An explanation is proposed based on the diffusion of impurity ions through a metal-semiconductor barrier, under the action of the applied field. D. G. AVERY

537.311.33

9248. Use of silicon *p–n* junctions for converting solar energy to electrical energy. R. L. CUMMEROW. Letter in *Phys. Rev.*, **95**, 561–2 (*July* 15, 1954).

Using relations for the efficiency of *p–n* junctions developed in terms of fundamental constants of semiconductors, it is suggested that the efficiency of conversion of solar energy to electrical energy should be about 17%. This is to be compared with measured efficiencies of 4%. A. E. DE BARR

537.311.33 : 621.3.012.8 : 621.314.7

9249. Physical theory of new circuit representation for junction transistors. J. ZAWELS. *J. appl. Phys.*, **25**, 976–81 (*Aug.*, 1954).

A circuit representation for a junction transistor is derived which places the mechanism of transistor action in evidence. The circuit is a direct interpretation of the diffusion equation and the boundary conditions which include the effects of base width modulation. It is found that the active part of the circuit is independent of frequency. A modification of the circuit for common emitter operation is shown and experimental results are given. A.

537.311.33 : 621.314.63

9250. Charge storage in junction diodes. E. L. STEELE. *J. appl. Phys.*, **25**, 916–18 (*July*, 1954).

A calculation is made which relates the physical properties of a junction diode to the troublesome spike current arising from hole storage in the germanium. This spike current results when the diode is suddenly switched from the conducting to the non-conducting state. For small germanium pellets, this current decay is exponential with a decay considerably shorter than that indicated by the hole lifetime in the material. For larger pellets the decay is a sum of exponentials giving a considerably longer decay time, still shorter, however, than the hole lifetime. A.

537.311.33 : 621.314.63

9251. Flicker noise in germanium rectifiers at very low- and audio-frequencies. D. K. BAKER. *J. appl. Phys.*, **25**, 922–4 (*July*, 1954).

An investigation of the frequency dependence of flicker noise in point contact and diffusion-alloy type germanium rectifiers is reported. The frequency range extends from approximately 10^{-3} to 10^{6} c/s and the inverse frequency law is found to hold over this range. The current dependence of the flicker noise at 10 c/s is also reported. A.

537.311.33 : 621.314.7

9252. On the current gain of germanium filamentary transistors. R. LAWRANCE, A. F. GIBSON AND J. W. GRANVILLE. *Proc. Phys. Soc.* [*London*] *B*, **67**, 625–35 (*Aug.*, 1954).

Mobility measurements have shown that injected carriers in transit down a Ge rod may be trapped and subsequently released. The trapping of minority carriers is expected to affect materially the performance of Ge devices under certain conditions. The influence of traps on the current gain of Ge filamentary transistors is described. Measurements of the variation of current gain with temperature, emitter current and signal frequency are described. A.

537.311.33 : 621.314.7

9253. Current multiplication processes in *n*-type germanium point-contact transistors. C. A. HOGARTH. *Proc. Phys. Soc.* [*London*] *B*, **67**, 636–43 (*Aug.*, 1954).

Briefly reviews theories to account for the high values of current gain α for Ge type A transistors, particularly at low values of emitter current. Experiments are described which suggest strongly that the "hole trap" theory as developed by Sittner is not applicable to type A transistors. A decrease in collector barrier height by the holes arriving there is shown to account, at least qualitatively, for the increase in α at low values of emitter current. A.

537.311.33 : 621.314.7 : 621.315.59

9254. The theory of rectification and injection at a metal-semiconductor contact. J. B. GUNN. *Proc. Phys. Soc.* [*London*] *B*, **67**, 575–81 (*July*, 1954).

The diffusion equations for holes and electrons are solved for the region of a semiconductor near a planar contact with a metal, using assumptions appropriate to transistor-quality Si and Ge. The hole and electron currents are calculated separately, and from them are

obtained the rectification equation and injection ratio of the contact. A.

537.312.5

9255. Interpretation of the anomalous variation of the photoconductivity of cadmium sulphide as a function of exciting intensity. G. Wlérick. *C.R. Acad. Sci.* [*Paris*] **238,** 2514–16 (*June* 28, 1954) *In French.*

537.312.5 : 537.311.33

9256. Power efficiency for the photovoltaic effect in a germanium grown junction. R. P. Ruth and J. W. Moyer. Letter in *Phys. Rev.*, **95,** 562–4 (*July* 15, 1954).

Measurements and discussion of observed efficiencies of conversion of incident radiation into power in a resistive load in series with a Ge *p–n* junction. The power efficiency increases with incident intensity over a large range of intensities in a manner similar to that in which the open-circuit photovoltage varies with the incident intensity. It is predicted that with a junction with an effective quantum efficiency of nearly unity, power efficiencies of 7 or 8% could be realized. A. E. de Barr

537.312.5 : 621.383.4

9257. A new silicon *p–n* junction photocell for converting solar radiation into electrical power. D. M. Chapin, C. S. Fuller and G. L. Pearson. Letter in *J. appl. Phys.*, **25,** 676–7 (*May*, 1954).

Photons of 1·02 eV ($\lambda = 1{\cdot}2\ \mu$) produce electron-hole pairs in Si which, in the presence of a *p–n* barrier, are separated and can be made to do work in an external circuit. Light of shorter wavelength produces the same effect but with waste of energy. The max. theoretical efficiency is 22% but this figure is reduced to $\sim 6\%$ through reflection of light at the Si surface and either recombination of the electron-hole pairs before they reach the *p–n* barrier or resistance loss if the *p–n* junction is deliberately placed too near the surface. With a surface-layer thickness $< 0{\cdot}0001$ in. and a special geometry of contacts an output of 60 W/in.^{2} is possible. H. G. M. Spratt

537.312.6

9258. Conductivity measurements on selenium. F. Eckart. *Ann. Phys.* [*Leipzig*] **14,** *No.* 6–8, 233–52 (1954) *In German.*

The variation of conductivity with temperature for solid and liquid Se depends on the purity of the Se and is affected by the adsorption of O. Se of almost spectroscopic purity was obtained by vacuum distillation. Conductivity-temperature curves of pure Se in vacuum ($\sim 10^{-3}$ mm) over a temperature range between 100°C and the melting point, gave an energy gap of 2·2–2·9 eV, the conductivity varying between 10^{-9} and 10^{-6} ohm^{-1} cm^{-1}. In air, the conductivity of Se exhibits hysteresis effects. J. Franks

537.312.6 : 538.22 : 538.63

9259. Variation of the electrical and magnetic properties of Sb and InSb at the melting point. G. Busch and O. Vogt. *Helv. phys. Acta,* **27,** *No.* 3, 241–9 (1954) *In German.*

Measurements of electrical conductivity, Hall effect and magnetic susceptibility of Sb and InSb as a function of temperature from low temperatures to 1100°K. The electrical conductivity of Sb increases by a factor of 1·6 on melting but the Hall constant and the magnetic susceptibility decrease by a factor of about 9. For InSb, the conductivity increases approximately fourfold whilst the Hall constant is 450 times, and the susceptibility 5·5 times smaller. The results are compared with the theory of metals.

A. E. de Barr

537.312.62

9260. Effect of hydrostatic pressure on the superconducting transition of tin. M. Garber and D. E. Mapother. Letter in *Phys. Rev.*, **94,** 1065 (*May* 15, 1954).

Pressures up to 100 atmospheres were applied through liquid helium and ΔH_c measured between 3·45°K and 3·70°K. At T_c, $\partial T_c/\partial p$ was found to be $4{\cdot}40 \pm 0{\cdot}20 \times 10^{-5}$ °K atmos^{-1}, slightly lower than found by Kan, Lasarev and Sudovstov [*J. Exp. Th. Phys. USSR,* **18,** 825 (1948)]. The discrepancy is thought to be due to slight irreversible effects, which were not taken into account in the earlier work.

D. Shoenberg

537.312.62

9261. Superconducting alloys. B. T. Matthias and E. Corenzwit. Letter in *Phys. Rev.*, **94,** 1069 (*May* 15, 1954).

In agreement with considerations of the influence of the average number of valence electrons per atom in alloys on their superconducting transition temperature, a 50–50 Mo–Ru alloy was found to be superconducting with $T_c = 10{\cdot}6$°K, close to the value for technetium, while T_c for a 50–50 Mo–Rh alloy was 1·75°K and for Mo_3Ir, 8·8°K. D. Shoenberg

537.312.62

9262. Superconductivity of pure metallic rhenium. J. K. Hulm. Letter in *Phys. Rev.*, **94,** 1390–1 (*June* 1, 1954).

A rod prepared by melting pure compressed powder showed nearly "ideal" superconducting behaviour, with a critical field given by $H_c = 188[1 - (T/1{\cdot}699)^2]$. A possible explanation for the much smeared out transition at rather higher temperatures previously found for powdered metal is discussed. D. Shoenberg

537.312.62

9263. The anisotropy of the effect of elastic deformation on the superconductivity of tin. C. Grenier. *C.R. Acad. Sci.* [*Paris*] **238,** 2300–3 (*June* 14, 1954) *In French.*

The effect is to produce, for a given magnetic field, a change in the superconducting transition temperature which varies with the type and crystallographic direction of the deformation. Max. change -45×10^{-6} °K.kg^{-1}cm^{-2} for strain along and zero for strain perpendicular to tetrad axis. A c_{44} or c_{66} shear produces only a secondary effect. The overall effect is adequately described in terms only of the effect of a hydrostatic pressure and of a strain along the tetrad axis. A. D. Le Claire

537.312.62

9264. Threshold field properties of some superconductors. E. Maxwell and O. S. Lutes. *Phys. Rev.*, **95,** 333–8 (*July* 15, 1954).

Some refined measurements of the critical field curves for tin, thallium, indium and mercury have been completed and the results compared with the specific

predictions of the Gorter–Casimir and the Koppe versions of the two-fluid model of superconductivity. Neither version is completely adequate, although each has points in its favour. The Koppe prediction of a universal critical field curve for all superconductors is not verified. The Gorter–Casimir α-model has greater flexibility than the Koppe model, and although it is capable of giving a fair description of the critical field data, it is in some respects also inconsistent with the data. The isotope effect in thallium has been observed and is consistent with the half-power law. A.

537.312.7

9265. Electrical resistivity of polycrystalline selenium at higher fields. M. KUWAGATA, E. OTSUKA AND M. TOMURA. Note in *J. Phys. Soc. Japan*, **9**, 300–1 (*March–April*, 1954).

Measurement of the resistivity of polycrystalline Se under fields up to 22 kV/cm and of the frequency characteristic of resistance up to 20 Mc/s indicated the existence of potential barriers at the grain boundaries. Annealing or addition of iodine appears not to change the carrier concentration but affects the barrier height. J. FRANKS

537.313 : 532.51

A general variational principle for dissipative systems. *See Abstr.* 8950

537.32 : 538.63 : 536.48

9266. Magneto-thermoelectric behavior of bismuth at liquid helium temperatures. M. C. STEELE AND J. BABISKIN. Letter in *Phys. Rev.*, **94**, 1394–5 (*June* 1, 1954).

The thermoelectric voltage across a Bi crystal at 4·38°K in the direction of the trigonal axis shows oscillations as a function of a magnetic field applied perpendicularly. The oscillations were of constant period in $1/H$, and this period agreed well with the corresponding period for the de Haas–van Alphen effect. D. SHOENBERG

537.36 : 538.639

9267. Centripetal and centrifugal electromagnetophoresis. A. KOLIN. Letter in *J. appl. Phys.*, **25**, 1065–6 (*Aug.*, 1954).

The previous theoretical estimate of the force upon small spheres suspended in a liquid, whose electrical conductivity differs from that of the spheres, when a current is passed through the liquid at right angles to a magnetic field [Abstr. 3321 (1953), 5639 (1954)], has now been verified by observing the rate of migration of polystyrene spheres of diameters in the order of magnitude of 100 μ suspended in NaCl solutions. The main experimental difficulty is the exclusion of electromagnetically engendered convection. Apparatus details with 2 diagrams are included for obtaining intense magnetic fields within small volumes.

H. H. HODGSON

ELECTRIC DISCHARGES 537.52

537.521.7

9268. Ions and barriers in electric discharges. G. K. M. PFESTORF AND R. S. N. RAU. *J. Indian Inst. Sci., B*, **35**, 179–86 (*July*, 1953).

Investigations on the effect of injecting ions (both positive and negative) into the spark gap, and also on the effect of paper screens in blocking the ions. A.

537.523.4

9269. A spectrophotometric study of gliding sparks. R. GASNIER AND A. VASSY. *C.R. Acad. Sci.* [*Paris*] **238**, 2407–9 (*June* 21, 1954) *In French.*

Describes the measurement of a spectral continuum emitted by 22 kV sparks in air, taking place over the surface of a quartz tube. The spark temperature is thereby estimated to be $\sim$ 13 000°K.

J. D. CRAGGS

537.523.5

9270. Arcing at electrical contacts on closure. V. The cathode mechanism of extremely short arcs. P. KISLIUK. *J. appl. Phys.*, **25**, 897–900 (*July*, 1954).

For Pt III, see Abstr. 5799 (1952). The available experimental data on the short arcs which occur on closure of electrical contacts with potential differences less than the minimum sparking potential are shown to be consistent with the hypothesis that the arcs are initiated and sustained by field emission electrons. Positive ions then carry less than 7% of the current at the cathode. The primary function of the ions is to supply sufficient positive space charge to maintain the high cathode field, but the action of the discrete ions near the cathode in creating a temporary pass in the potential barrier may result in the attainment of sufficient electron emission to sustain the arc at values of the cathode field somewhat lower than that required by the Fowler–Nordheim equation for the same current density. It is shown that the supply of volatile impurities on the electrode surface is critical in determining the breakdown field and the minimum arc current. A.

537.523.5 : 621.3.014.31

9271. The measurement of the radial temperature distribution in the electric arc. B. GROSS. *Elektrotech. Obzor*, **42**, *No.* 7–8, 415–28 (1954) *In Czech.*

A method for measuring the radial temperature distribution in electric arcs is developed mathematically in great detail, and an arrangement utilizing emission spectra is described. Temperatures vary as a function of ωt in the case of a.c. arcs, and it is shown that a "temperature hysteresis" exists, the peak of the temperatures lagging behind the peak of the current cycle. The measured radial temperature distribution curves for an a.c. arc and $\omega t = 30, 45, 60, \ldots 150°$, as well as the corresponding temperature hysteresis loop and isothermal lines are shown. H. NOREL

537.525

9272. Sub-normal discharges. K. G. EMELEUS AND J. A. BURNS. *Brit. J. appl. Phys.*, **5**, 277–80 (*Aug.*, 1954).

When very small currents are passed through mercury vapour in cylindrical tubes, the characteristic-current v. voltage-gradient curves for the positive column have negative slope. A previous analysis of conditions in the column based on ambipolar diffusion theory is restated and extended somewhat in terms of plasma-sheath theory. It appears that the plasma-sheath boundary region of high current discharges expands to fill the cross-section when the current is low. Probe experiments on positive columns in

mercury vapour and other gases indicate the probable presence of positive space charges throughout the tube when the current density is small. It is suggested that this may be a common property of many discharges with small current density. 23 references are given to literature on the subject. A.

537.525.4

9273. On the initiation of electric discharges *in vacuo*. R. ARNAL. *C.R. Acad. Sci.* [*Paris*] **238,** 2061–3 (*May* 24, 1954) *In French.*

Discusses, with reference to experimental data, the influence of the pre-breakdown liberation of gases from electrodes in vacuum breakdown between undegassed electrodes. J. D. CRAGGS

537.525.4

9274. On breakdown conditions between metallic surfaces *in vacuo* as determined by the electrical supply. R. ARNAL. *C.R. Acad. Sci.* [*Paris*] **238,** 2402–3 (*June* 21, 1954) *In French.*

Follows earlier notes by the same author on pre-breakdown discharge currents in short gaps, e.g. 3 mm gaplength at 10^{-4} mm Hg pressure, 60 kV applied. The finite build-up time of these currents enables higher voltages to be applied if they are impulsive. J. D. CRAGGS

537.525.72

9275. Study of an electric discharge induced [by induction heating] without electrodes in neon. F. CABANNES. *C.R. Acad. Sci.* [*Paris*] **238,** 1979–81 (*May* 17, 1954) *In French.*

A short note on the application of induction heating to the study of conductivity in electrical discharges in rarefied gases. C. G. MORGAN

537.525.8

9276. The calculation of the subnormal [glow discharge] characteristic. G. ECKER. *Naturwissenschaften,* **41,** *No.* 8, 184–5 (1954) *In German.*

The study of glow discharges at very low current densities is of interest because of the incipient "quasi-neutrality" of the plasma. In this note the relation between electric field and current density is calculated and compared with exptl. data, with excellent agreement. The results are shown graphically. Current densities vary from about 5×10^{-7} to 5×10^{-5} A/cm^2 and the corresponding fields vary from about 4 to 1 V/cm (pressures $\sim$ 1–10 mm Hg). J. D. CRAGGS

537.525.8

9277. A theory of cathode erosion in glow discharges. G. ECKER AND K. G. EMELÉUS. *Naturwissenschaften,* **41,** *No.* 8, 185–6 (1954) *In German.*

A discussion of cathode sputtering in which the diffusion processes governing the eroded electrode vapour are considered. A formula for the effective erosion rate is given. J. D. CRAGGS

537.525.8

9278. On the radial extent of glow in microwave gas discharge between coaxial cylinders. K. MITANI. Note in *J. Phys. Soc. Japan,* **9,** 299–300 (*March–April,* 1954).

A short note outlining a method of calculating spatial variations of $n\nu$ (electron density × production rate of electrons per electron) in certain microwave discharges. The gas pressure was $\sim$ 4 mm Hg.

J. D. CRAGGS

537.525.8 : 541.138

Chemical synthesis from free radicals produced in microwave fields. *See Abstr.* 9707

537.525.83

9279. Cathode sputtering in glow discharges. G. ECKER AND K. G. EMELÉUS. *Proc. Phys. Soc.* [*London*] *B,* **67,** 546–52 (*July,* 1954).

The analysis and interpretation of experiments on cathode sputtering in glow discharges requires definite knowledge of the behaviour of the metal atoms after they leave the cathode. Previous theoretical investigations of this neglect important factors, or are based on imperfectly realizable assumptions, and are not in good agreement with experiment. In particular, application of these theories leads to qualitative and order-of-magnitude discrepancies with low-pressure experiments. Authors have now attempted to make a more precise description of the behaviour of the metal atoms. It has been shown that hitherto largely neglected effects of initial scattering, lateral boundaries, distribution of current over the cathode, high emission velocities and the difference in mass between metal atoms and gas molecules, are of fundamental importance. The new formulation removes most of the old difficulties and discrepancies. It also shows definitely, however, that the phenomena are so complex that it will probably never be possible to develop a theory of sufficient accuracy to permit of exact conclusions being drawn from the experimental data. A.

537.527.2

9280. Researches on discharges between point and plane in compressed air and CO_2. A. BOULLOUD. *C.R. Acad. Sci.* [*Paris*] **238,** 1981–3 (*May* 17, 1954) *In French.*

A study of pre-breakdown currents at pressures above that corresponding to the minimum sparking potential. C. G. MORGAN

537.529

9281. On the criterion for dielectric breakdown in ionic crystals. J. J. O'DWYER. *Austral. J. Phys.,* **7,** 36–48 (*March,* 1954).

Previous theories on the criterion for electronic breakdown in ionic crystals are reviewed, in particular those of Fröhlich and Heller. It is shown that the ideas proposed by Heller are based on insufficient examination of the physical picture of breakdown, and the validity of Fröhlich's criterion is vindicated so long as electron-lattice collisions determine the distribution function. However, for the relatively high densities of conduction electrons existing just before breakdown the effect of electron–electron collisions may well be more important than the effect of electron–lattice collisions in determining the distribution function. Accordingly a critical field strength is calculated for a Maxwellian distribution of conduction electrons by a method which is a modification of Fröhlich's work. Comparison with the somewhat inadequate experimental results existing at present suggests that the breakdown field should be identified with the critical field originally proposed by Fröhlich. A.

X-RAYS 537.531

537.531 : 535.33

9282. The '*s*-*t*' doublet in the mercury *L* X-ray spectrum. C. MANDE. *Proc. Nat. Acad. Sci. India A*, **21**, *Pt I*, 11–15 (1952).

Two new lines 1308·5 X.U. and 1371·8 X.U. have been discovered in the *L*-emission spectrum of mercury. It is shown that these are the forbidden lines "*s*" and "*t*" corresponding to the transitions $L_{III}M_{III}$ and $L_{III}M_{II}$. It is also shown that these lines form a regular doublet. A.

537.531 : 535.33

9283. Studies of the "technical" continuous spectrum of X-rays. I. Standardization of spectral representations. H. TELLEZ-PLASENCIA. *J. Phys. Radium*, **15**, 352–6 (*May*, 1954) *In French.*

The "technical" spectrum means the spectrum of X-rays outside the X-ray tube, as distinct from the "physical" spectrum actually emitted by the target. Methods of standardizing the results of different methods and forms of spectroscopy are considered.

A. R. STOKES

537.531 : 535.822.9

9284. An improved X-ray shadow projection microscope. V. E. COSSLETT AND H. E. PEARSON. *J. sci. Instrum.*, **31**, 255–7 (*July*, 1954).

An apparatus for producing a point source of X-rays, less than 1 μ in diameter, is described. A tungsten hairpin filament is employed, and two magnetic electron lenses form a demagnified image of it on a metal foil which serves as both target and window. The tube is demountable; a variety of different targets has been employed (copper, silver, tungsten) for producing X-rays of different characteristic wavelength. The maximum voltage applied has been 20 kV, but simple modifications would permit 30 to 40 kV to be used. The optimum conditions of operation are briefly discussed. The tube has been constructed primarily for the projection of X-ray shadow images of small specimens. A.

537.531 : 535.822.9

9285. A system of spherical mirrors giving magnified images with X-rays. M. MONTEL. *C.R. Acad. Sci.* [*Paris*] **239**, 39–41 (*July* 5, 1954) *In French.*

Previous X-ray microscopes have suffered from considerable geometric aberrations. A system using a type of roof prism is described, which is free from astigmatism, distortion or sloping of the focal plane. A resolving power of 1 μ with a magnification $\times 100$ has been obtained experimentally. R. W. FISH

537.531 : 537.533.75

9286. On the influence of discrete energy losses of electrons on the structure of isochromatic X-rays in the neighbourhood of the short wave limit. C. GERTHSEN AND L. ALBERT. *Z. angew. Phys.*, **6**, 196–8 (*May*, 1954) *In German.*

The intensity-voltage characteristics of X-rays from gold, platinum and tungsten anticathodes near the short wave limit exhibit a step-like fine structure. This is associated with the discrete energy loss of electrons previously considered by Ruthemann [Abstr. 2548 (1949)] and Möllenstedt [Abstr. 5038 (1950)].

C. G. MORGAN

537.531 : 539.166

9287. General considerations regarding the dosimetry of roentgen and gamma radiation: addendum. W. J. OOSTERKAMP. *Appl. sci. Res. B*, **3**, *No.* 6, 477–8 (1954).

See Abstr. 5663 (1954).

537.531.08 : 615.849.1 : 616.073.75

9288. Distribution-dosimetry of radiation fields in the living subject. W. KOSSEL, U. MAYER AND H. C. WOLF. Note in *Naturwissenschaften*, **41**, *No.* 9, 209 (1954) *In German.*

When Mn-activated $CaSO_4$ is irradiated by X-rays and afterwards heated, it exhibits thermoluminescence. The emitted light is measured with a photomultiplier and is proportional to the X-ray dosage received. Many very small sealed sources (2–3 mm dia.) can be distributed within irradiated tissues or cavities, and used as dose indicators. $\pm 5\%$ reproducibility is claimed, though constancy of response at different X-ray wavelengths has not yet been fully investigated.

D. V. MABBS

537.531.08 : 615.849.1 : 616–073.75

9289. The application of distribution-dosimetry to the intra-vaginal X-irradiation of the parametria. H. BURGER, J. LEHMANN AND U. MAYER. Note in *Naturwissenschaften*, **41**, *No.* 9, 209 (1954) *In German.*

Describes with diagrams experimental arrangements using small (15 mm $\times$ 2 mm) thermoluminescent sources of Mn-activated $CaSO_4$ (see preceding abstract). These are inserted along the length of a catheter which is introduced into the rectum to record dosage during intra-vaginal X-irradiation of a parametrium. Results are given. A smaller source (10 mm $\times$ 0·7 mm) can be inserted subcutaneously through a hypodermic needle making direct tumour dosage measurement possible. D. V. MABBS

CATHODE RAYS . POSITIVE RAYS 537.533./534

537.533.2 : 537.583

9290. Temperature-and-field emission of electrons from metals. W. W. DOLAN AND W. P. DYKE. *Phys. Rev.*, **95**, 327–32 (*July* 15, 1954).

Both the current density and the distribution in energy of electrons emitted from metals are calculated for various combinations of temperature, applied surface electric field and work function. A wider range of those variables than previously achieved is made possible by use of numerical integration. The integrand is the usual function based on the free-electron theory of metals and the wave-mechanical barrier transmission coefficient of Sommerfeld and Bethe which assumes a classical image force and a plane surface. Results, which are presented in graphical form, are consistent with the Fowler–Nordheim field emission equation for low temperatures, and with the Richardson thermionic emission formula at low fields. Predicted emission at temperatures up to 3000°K is compared with cold emission at fields between 10^7 and 10^8 V/cm. A qualitative comparison is made between the present results and previous experiments on the transition between field emission and the vacuum arc.

A.

537.533.3 : 538.566 : 621.372.8 : 621.385.833

9291. A combined slow-wave circuit and beam focusing structure. P. Rice. Letter in *J. appl. Phys.*, **25**, 680–1 (*May*, 1954).

An experimental beam-focusing tube was built using alternate N and S magnetized rings which formed also alternate projections inside a waveguide suitable for reducing the velocity of an electromagnetic wave. A circular beam of electrons was directed at 750 V into a 4·6 mm dia. copper tube, 5·7 cm long, axially traversing this system. With a cathode current of 7·8 mA, a final beam of over 6 mA could be obtained at a sharply defined magnetic field of 150 gauss. J. H. FREMLIN

537.533.33 : 535.317.5

Third-order aberrations of "doubly symmetric" systems. *See Abstr.* 9043

537.533.33 : 621.385.833

9292. Requirements contributing to the design of devices used in correcting electron lenses. G. D. Archard. *Brit. J. appl. Phys.*, **5**, 294–9 (*Aug.*, 1954).

The voltage requirements for a modification of the spherical correction system of Seeliger are given. The potential changes introduced by unintentional asymmetries of non-rotationally-symmetrical elements are calculated and an expression is given for the resulting aberrations. It is shown that some of these can be removed by the Stigmator of Rang [Abstr. 1880 B (1950) *Optik*, **5**, 518–30 (*Nov.–Dec.*, 1949)], but that others remain which would necessitate positioning to 1 μ in order to attain a resolution improvement of three times. With the addition of certain other elements, tolerances could be raised to 10 μ for a resolution improvement of ten times. In the course of the work, the mechanism of Seeliger's system and its suggested modification are compared with another system proposed by Burfoot. A.

537.533.335 : 537.533.35

9293. On the chromatic field aberration of the magnetic electron lens in the electron microscope. N. Morito. *J. appl. Phys.*, **25**, 986–94 (*Aug.*, 1954).

The chromatic field aberration of the magnetic lens in the electron microscope is theoretically studied. Good results are obtained for the coefficient of the chromatic difference in magnification of the objective, taking into account the inclination of the principal illuminating rays. The same coefficient of the intermediate lens increases rapidly as the magnification is reduced by the intermediate lens. The calculated results agree well with experimental results. Calculated results are given for the coefficients of chromatic difference in rotation of all lenses as well as for the coefficient of chromatic difference in magnification of the projection lens. A.

537.533.73

9294. A high precision electron-diffraction unit for gases. L. O. Brockway and L. S. Bartell. *Rev. sci. Instrum.*, **25**, 569–75 (*June*, 1954).

An electron-diffraction unit incorporating a rotating sector has been developed which makes possible the accurate and objective measurement of the intensity of electrons diffracted by free atoms and molecules. The diffraction data afforded are sufficiently precise to permit the calculation of the distribution of electrons in atoms and the amplitude of vibration of atoms in molecules, as well as interatomic distances that are comparable in accuracy in suitable cases to those obtained by microwave spectroscopy. A description of the essential components of the unit is given together with some data on performance and discussion of the use of the apparatus. A.

537.533.73

9295. Diffraction of 1 MeV electrons. M. Papoular. *C.R. Acad. Sci.* [*Paris*] **238**, 2411–12 (*June* 21, 1954) *In French.*

High-energy electrons from a linear accelerator were passed through a monochromator and a transmission electron diffraction pattern from an evaporated gold specimen was obtained. Calibration of the electron energy can be carried out by this means. A.E.I. RESEARCH LABORATORY

537.533.74

9296. The multiple scattering of electrons and positrons. C. B. O. Mohr and L. J. Tassie. *Austral. J. Phys.*, **7**, 217–29 (*June*, 1954).

The angular distribution of the single scattering of 33, 121 and 1065 keV electrons at small angles in gold is calculated and compared with the distributions given by the Born approximation and by the WKB method as used by Molière (1947). The single scattering distribution for 1065 keV electrons is integrated numerically to give mean square angles of multiple scattering, and these are compared with the values given by the various multiple scattering theories. The results are discussed in conjunction with the experimental data for gold and other elements. The discrepancy between theory and the recent experiments with beryllium [Abstr. 1857 (1952)] is shown not to be explained by the use of the Hartree instead of the Thomas–Fermi field. The difference of the root mean square angle for electrons and for positrons is estimated for gold and argon, and its value for argon—the only element for which this difference has been measured—is much less than the observed value. A.

537.533.74

9297. Backscattering of kilovolt electrons from solids. E. J. Sternglass. *Phys. Rev.*, **95**, 345–58 (*July* 15, 1954).

The total number and energy distribution of backscattered electrons at 0·2–4 keV incident energy (V) have been measured for six elements using electrostatic retarding potential techniques. For atomic number $Z \lesssim 30$, backscattering was found to be essentially independent of V and almost linearly dependent on Z. For $Z \gtrsim 30$, backscattering decreases with decreasing V below 2–3 keV to values less than those for elements of $Z \simeq 30$, and it no longer is a simple function of Z. The ratio of the mean energy of the backscattered electrons to that of the primaries is found to be close to one-half for $Z = 6$ and to increase only slightly for the heavier elements. These results are shown to indicate a dominant rôle of inelastic processes in the scattering of intermediate energy electrons, in contrast to scattering at very high energies, where elastic interactions control the phenomenon. A.

537.533.74 : 539.152.1

9298. Phase-shift calculation of high-energy electron scattering. D. R. YENNIE, D. G. RAVENHALL AND R. N. WILSON. *Phys. Rev.*, **95**, 500–12 (*July* 15, 1954).

The details of a phase-shift calculation of high-energy electron scattering by nuclei are given, together with some preliminary results. A new method for summing the Legendre series for the Coulomb scattering amplitude is described. The results indicate that the first Born approximation does not give cross-sections accurate enough for a reliable interpretation of the experiments. From a comparison of the few theoretical cross-sections already obtained with the experiments in gold at 125 MeV, very tentative conclusions about the nuclear charge distribution are drawn. It is pointed out that an analysis of results at two or more energies will be a much more sensitive test of possible charge distributions. A.

537.533.74 : 539.152.1

9299. High-energy electron scattering and nuclear structure determinations. II. R. HOFSTADTER, B. HAHN, A. W. KNUDSEN AND J. A. MCINTYRE. *Phys. Rev.*, **95**, 512–15 (*July* 15, 1954).

For Pt I, see Abstr. 1389 (1954). Elastic scattering measurements have been carried out with electrons in Au^{197} at energies of 84, 126, 154, and 183 MeV and in Pb^{208} at 84, 153, and 186 MeV. Diffraction effects are observed which appear to vary with momentum and angular position as if a fundamental parameter $p \sin(\theta/2)$ were equal to a constant for a given diffraction feature. Such a behaviour would be predicted by the Born approximation. A comparison of the scattering in Au^{197} and Pb^{208} suggests that inelastic scattering does not materially influence the scattering curves presented. The appearance of diffraction effects indicates a model more nearly uniform in charge density than early tentative conclusions based on Born approximation calculations. A.

537.533.74

9300. The scattering and polarization of electrons by gold. C. B. O. MOHR AND L. J. TASSIE. *Proc. Phys. Soc.* [*London*] *A*, **67**, 711–18 (*Aug.*, 1954).

Using semi-analytic methods, accurate calculations of phase shifts are carried out for an exponentially screened field for electrons with energies between 0·9 and 121 keV. Utilization of these values shows that screening has a relatively small effect on the scattering above 33 keV and on the polarization above 121 keV. The precise form of the field becomes important below 5 keV, where diffraction effects become marked. The polarization is a maximum near 120°, both for the screened and the unscreened field, in agreement with recent experiments, though near the maximum the experimental value is only about half the theoretical. A.

537.533.74 : 539.166.74

9301. Polarization phenomena of electrons and photons. II. Results for Compton scattering. F. W. LIPPS AND H. A. TOLHOEK. *Physica*, **20**, 395–405 (*July*, 1954).

For Pt I, see Abstr. 5687 (1954). The Compton cross-section is given, including all polarization details. The use of the 3-dimensional polarization vectors ξ and ζ, for photons and electrons, makes the results very explicit, so that any specific polarization effect can easily be obtained from the general formula. A special discussion and numerical results are given for the following polarization effects: (*a*) The detection of circularly polarized γ-radiation by Compton scattering from magnetized iron. (*b*) The production of polarized electron beams by incident circularly polarized radiation. (*c*) The production of polarized electron beams by scattering unpolarized γ-radiation from magnetized iron. A.

537.533.79 : 621.385.833

9302. Electron bunches of short time duration. E. W. ERNST AND H. VONFOERSTER. Letter in *J. appl. Phys.*, **25**, 674–5 (*May*, 1954).

The times in question are $\sim 10^{-12}$ sec. The beam is first chopped at 3 kMc/s in a Lecher wire deflection circuit. A group of electrons selected by a slit is then passed in to a 3 kMc/s cavity and bunched. By adjustment of relative phase the desired operation can be obtained. A pulse of $\sim 2\times10^{-12}$ sec duration was obtained. A. H. W. BECK

537.533.8

9303. A method of investigating the secondary emissive properties of insulators. C. N. W. LITTING. *Brit. J. appl. Phys.*, **5**, 289–93 (*Aug.*, 1954).

Methods are described for measuring the secondary emission ratio (δ) of an insulator together with the energy distribution of the emitted electrons. The secondary emission ratio is obtained by means of a type of electron beam voltmeter which is used to measure the potential of the bombarded surface thus allowing the rate of change of charge to be determined. The results show good agreement with those obtained by another method and also check with d.c. measurements on metal surfaces. The energy distribution of the secondary electrons from an insulator surface is measured using the electron beam voltmeter and also by a method employing cathode potential stabilization. As the electron beam voltmeter method for measuring δ depends on the ratio of two time measurements it should be capable of greater accuracy than methods which involve the measurement of output pulses from an amplifier. A.

537.533.8

9304. On the thick target bremsstrahlung spectrum at relativistic energies. K. PHILLIPS. *Proc. Phys. Soc.* [*London*] *A*, **67**, 669–72 (*Aug.*, 1954).

The bremsstrahlung energy distribution has been measured for 9 MeV electrons striking a thick copper target. This method involves the energy measurement of the photo-protons produced in the $H^2(\gamma, n)H^1$ reaction. The experimental results are compared with a theoretical distribution which is deduced from the thin target bremsstrahlung spectrum. By invoking the usual expressions for the energy loss by ionization and radiation of the incident electrons in the target reasonable agreement between experiment and theory is found. A.

537.533.8 : 548.0

9305. Secondary electron emission from different faces of single crystals of copper, covered with single crystal films of copper oxide. N. B. GORNYĬ. *Zh. éksper. teor. Fiz.*, **26**, *No.* 1, 79–87 (1954) *In Russian.*

The dependence of the coefficient of secondary

electron emission δ on the energy of the primary electrons V_p (50–1000 V) has been investigated on the (100), (110) and (111) faces of copper single crystals covered with a single-crystal film of oxide and on polycrystalline copper surfaces, covered with polycrystalline oxide. The curves $\delta = f(V_p)$ for the specimens investigated show small differences which are most apparent in the range of comparatively small primary electron energies (100–300 V). The increase of δ with decreasing work function is not explicable in terms of present theories of secondary electron emission. J. W. MENTER

537.533.8 : 548.0

9306. Secondary electron emission from different faces of single crystals of zinc, covered with single crystal films of zinc oxide. N. B. GORNYĬ. *Zh. éksper. teor. Fiz.*, **26**, *No.* 1, 88–97 (1954) *In Russian.*

Gornyĭ has made an experimental study of the coefficient of secondary electron emission δ on the (0001) and (10$\bar{1}$0) faces of zinc single crystals and on polycrystalline zinc with primary electron energies in range 50–1000 V. He also studies the energy distribution of secondary electrons with primary energies of 75 and 800 V. Significant differences were found between curves $\delta = f(V_p)$ for specimens investigated and also in distribution of secondary energies for primary energy of 75 V. A study of the proportion of elastically scattered electrons in the primary energy range 5–19 V shows that this is greater for the (10$\bar{1}$0) face than for the (0001) face. J. W. MENTER

537.534

9307. A new interpretation of the adiabatic approximation. P. A. STURROCK. *Atomic Energy Res. Establ.* [*Harwell*] *Mem. T/M* 88, 6 *pp.* (1953).

The customary formula for the adiabatic invariant of a slowly changing cyclic process as an integral taken over one cycle (in time) along a single trajectory may be replaced by an integral taken at a definite time but over one cycle of a phase parameter (which will enumerate a family of trajectories). This formulation is more convenient for work upon strong-focusing particle accelerators since then one need not know explicitly the forms of trajectories between the appropriate planes of reference. This form of the adiabatic invariant resembles closely the Poincaré invariant (which is a strict invariant) and a comparison of the two leads to an interpretation of the adiabatic approximation as the assumption that there are no preferred phases. A.

537.534.3

9308. High-order focusing by a uniform magnetic field with straight-line boundaries. E. T. S. WALTON. Letter in *Nature* [*London*] **173**, 1147–8 (*June* 12, 1954).

An investigation of focusing in mass spectrographs, employing a special drawing instrument, is described. For perfect focusing at a given point, of all particles emitted with the same momentum from a given point source, an arbitrary choice of entrance boundary of the field is made. A pointer is moved over this boundary and the instrument automatically traces the required exit boundary. By proper choice of a straight-line entrance boundary, the corresponding exit boundary is essentially a straight line also. Results indicate that accurate focusing of particles emitted into a wide angle and of slightly different momenta can be obtained. N. M. KING

537.534.3

9309. Mass spectrometric analysis of ions from the field microscope. M. G. INGHRAM AND R. GOMER. Letter in *J. chem. Phys.*, **22**, 1279–80 (*July*, 1954).

The nature of positive ions desorbed from a tungsten tip by high electrostatic fields was determined, by allowing them to pass through the screen of the field-emission microscope into a mass spectrometer with an electron multiplier as detector. For hydrogen ions, peak widths increased above 6 V/Å, with consequent decrease in peak heights. It is inferred that for high fields, auto-ionization is the predominant effect, occurring at 3–100 Å from the tip. For lower fields, ionization takes place within 5 Å of the tip. It is suggested that field ionization occurs by an electron tunnelling process. N. M. KING

537.534.3

9310. A mass spectrograph for the analysis of solids. N. B. HANNAY. *Rev. sci. Instrum.*, **25**, 644–8 (*July*, 1954).

A double focusing mass spectrograph for the analysis of low concentrations of impurities in solids has been developed. The instrument is of the Mattauch type and is designed for either photographic or electrical ion detection. The construction and performance of the instrument are discussed. Bulk concentrations below 0·1 part per million, and surface contaminants of less than 0·1 monolayer, can be detected in short exposures using a photographic plate. A.

537.534.6

9311. On the neutralization of the space charge in positive ion beams by accumulation of electrons; study of the time of neutralization. R. BERNAS, L. KALUSZYNER AND J. DRUAUX. *J. Phys. Radium*, **15**, 273–80 (*April*, 1954) *In French.*

The neutralization of space charge in intense beams of positive ions is discussed. A simple experimental procedure, which shows the existence of a finite time T necessary for the neutralization, and which enables measurements of T to be made, is described. It is verified that the accumulation of electrons liberated in collisions between ions of the beam and atoms of the residual gas is responsible for the compensation. The variation of T is plotted as a function of several parameters (pressure, current, energy) for argon ions in argon, and Mg^+ ions in several gases. Absolute values of T measured range from 30 to 200 μsec, depending on the conditions. N. M. KING

537.534.74

9312. Proton-proton scattering from 40 to 95 MeV. U. E. KRUSE, J. M. TEEM AND N. F. RAMSEY. Letter in *Phys. Rev.*, **94**, 1795–6 (*June* 15, 1954).

Measured using scintillation counters to detect the protons scattered from hydrocarbon targets. The angular distribution from 90° to 40° in the c. of m. system at 95 MeV and the cross-section at 90° for lower energies was measured. Graphs are given of this angular distribution, and of the cross-sections at 90°, including results previously reported. J. HUGHES

537.534.74

9313. Analysis of proton-proton scattering at 9·7 MeV. H. H. Hall. *Phys. Rev.*, **95**, 424–5 (*July* 15, 1954).

The Berkeley data on the 9·7-MeV differential scattering cross-section have been subjected to a phase shift analysis. An S-phase shift in agreement with earlier work has been found, but with somewhat better precision. This value agrees with that expected from a Yukawa potential. This experiment shows some suggestion of a repulsive P-state interaction, while the Los Alamos data show a similar but attractive P-state interaction. It is observed that the apparent discrepancy in the small-angle differential scattering cross-section is large enough to warrant further measurements in the small-angle region. A.

537.534.74

9314. The elastic scattering of 18-MeV protons by Al, Fe, Ni, and Cu. I. E. Dayton. *Phys. Rev.*, **95**, 754–8 (*Aug.* 1, 1954).

The absolute differential cross-section for the elastic scattering of 18 MeV protons has been measured for Al, Fe, Ni and Cu at 35 or more angles between 15 degrees and 172 degrees. The estimated standard deviation of each point is 3%. The scattered protons are detected by a sodium iodide crystal whose energy resolution is about 2·5%, and the resulting pulse spectrum is recorded on a 15-channel pulse-height analyser. For all materials used, protons scattered inelastically to the lowest known level are completely resolved from the elastic group. The differential cross-sections for the four elements are qualitatively similar, showing pronounced structure and low cross-sections in the background direction. The experimental results are in disagreement with cross-sections predicted by the optical model of the nucleus. A.

537.534.74

9315. Small-angle cross sections for the scattering of protons by tritons. M. E. Ennis and A. Hemmendinger. *Phys. Rev.*, **95**, 772–5 (*Aug.* 1, 1954).

The proton-triton differential scattering cross-section has been measured for centre-of-mass angles between 20° and 150° and proton energies in the range 1 to 2·55 MeV. Probable errors vary between 3 and 5%.

537.534.74 : 539.152.1

9316. Polarization in high-energy elastic nucleon-nucleus scattering. B. J. Malenka. *Phys. Rev.*, **95**, 522–6 (*July* 15, 1954).

The proposal to explain the comparatively large polarization observed in high-energy elastic proton-nucleus scattering by means of the spin-orbit interaction used in the shell model of the nucleus is examined. Three simple examples are considered in first Born approximation. The approximate magnitude and the approximate location of the maximum polarization for 340 MeV nucleons on carbon is in rough agreement with experiment. However, regions of negative polarization also seem to be predicted by the theory. Finally, an approximate method to calculate the polarization for high energy and small scattering angle is suggested. A.

537.534.75

9317. Range-energy relation in nuclear track emulsions for protons of energy up to 21 MeV. W. M. Gibson, D. J. Prowse and J. Rotblat. *Nature* [*London*] **173**, 1180–1 (*June* 19, 1954).

Measurements on 12–21 MeV protons in "dry" C2 emulsions are reported and compared with existing data. A complete range-energy table for 0–21 MeV protons is given. J. J. WILKINS

537.534.75

9318. Range and charge of energetic nitrogen ions in nickel. H. L. Reynolds, D. W. Scott and A. Zucker. *Phys. Rev.*, **95**, 671–4 (*Aug.* 1, 1954).

The range of nitrogen ions in nickel was measured for energies from 8 to 29 MeV. The rate of energy loss is nearly constant over this range and has a value of 3·7 MeV/(mg.cm^{-2}). The average charge of nitrogen ions in nickel was determined as a function of velocity. At a velocity of $1{\cdot}93\times10^9$ cm/sec (27·3 MeV), the average charge is 6·2. A.

537.534.9 : 621.387.032.77

9319. Sputtering at low ion velocities. G. Wehner and G. Medicus. *J. appl. Phys.*, **25**, 698–702 (*June*, 1954).

Low sputtering rates are measured by means of the probe technique in a plasma. The displacement of the probe curve along the voltage axis (and its change in shape) when the probe is covered with a material of different work function, sputtered from a sputtering electrode, is a dependable measure for the thickness of the sputtered layer. The method is very sensitive, generally applicable and was applied especially to answer the question of a threshold voltage U_0 for sputtering. The sputtering rate for Pt in Xe, in the region of low ion energies ($50 < U_s < 200$ eV) is approx. $\propto (U_s - U_0)^2$ with $U_0 = 40$ eV. A.

DISCHARGE TUBES . COUNTERS 537.54

537.542

9320. Theory of oscillating-electron ion sources. M. Hoyaux. *J. Phys. Radium*, **15**, 264–72 (*April*, 1954) *In French.*

These sources can operate in two distinct states; the "normal state" in which the electron and ion currents are very small, and the "superstate" in which they are much greater. For certain values of pressure and magnetic field it is possible to pass from one state to the other. In Pt I, the theory of the normal state is discussed, with reference to a simple magnetically-focused electron beam oscillating between two potential barriers in the source. Pt II is concerned with the superstate, the fundamental working hypothesis being that the electronic space charge is almost entirely compensated by the ionic space charge. The ion currents available within the source are calculated. (Calculation of the actual currents extracted constitutes a different problem and is not considered here.) In the normal state, for very low pressures, it is shown that the available ion current is independent of the electron current, I, and is proportional to the pressure, p; the electron density is then independent of the distance from the axis. For slightly greater pressures, the current becomes proportional to

$(pI)^{\frac{1}{2}}$; the electron density is effectively independent of the distance from the axis up to a certain radius, and thereafter decreases hyperbolically. Operating in the superstate at high pressures, there is a true discharge with the appearance of a plasma; the available ion current is proportional to I and does not depend on p. The electron density and potential are then Gaussian and parabolic functions, respectively, of the distance from the axis. Experimental verification of the theoretical predictions has been obtained (see abstract following). N. M. KING

537.542

9321. Probe measurements in an oscillating-electron ion source. M. HOYAUX, R. LEMAITRE AND P. GANS. *J. Phys. Radium*, **15**, 80 *A*–84 *A* (*May Suppl.*, 1954) *In French.*

An experimental investigation designed to verify the theory of these ion sources, as given by Hoyaux (preceding abstract), is described. Curves obtained from the various measurements, made in mercury vapour, using cylindrical and plane probes, are included. Results obtained with plane probes were more difficult to interpret, and it is proposed to extend the observations to hydrogen gas, using cylindrical probes only. In accord with theory, the radial distribution of electron density is close to a Gauss curve, while the radial potential distribution is essentially parabolic. Observed and theoretical values for electron density distribution agree to within about 3%. N. M. KING

537.542

9322. Two ion sources for the production of multiply charged nitrogen ions. R. J. JONES AND A. ZUCKER. *Rev. sci. Instrum.*, **25**, 562–6 (*June*, 1954).

Two ion sources have been developed for the production of milliamperes of N^+, N^{2+}, N^{3+} and N^{4+} ions. Under good operating conditions, 28 mA of N^{3+} and 10 mA of N^{4+} are produced. Details of source construction are given and a method for analysing the source output is presented. Characteristics of both sources as a function of arc current and arc voltage are investigated. A.

537.542 : 537.534.3

9323. An improved mass spectrometer ion source. O. A. SCHAEFFER. *Rev. sci. Instrum.*, **25**, 660–2 (*July*, 1954).

Modifications of an electron impact ion source for a 60° mass spectrometer are described. The changes consist of (1) an almost completely enclosed ionization region which greatly reduces the contribution of ions from thermal decomposition products on the filament and reduces the contribution of background peaks, and (2) a built-in aligned and stronger magnetic field which eliminates source magnet adjustment, collimates the electron beam better and permits the use of a higher repeller voltage, thereby increasing the collection efficiency for ions with initial kinetic energy. The performance of the source is described. A.

537.542

9324. Evaluating the performance of the internal counter. J. S. NADER, G. R. HAGEE AND L. R. SETTER. *Nucleonics*, **12**, 29–31 (*June*, 1954).

The experimental determination of counting efficiency in an internal β-counter is outlined. The counter is of the gas-flow type (argon–methane), taking large 50 mm diameter planchets. L. R. SHEPHERD

537.542

9325. Moseley's law applied to proportional counter resolution of adjacent elements. C. H. HENDEE AND S. FINE. Letter in *Phys. Rev.*, **95**, 281–2 (*July* 1, 1954).

It is shown that the resolution of X-rays of adjacent elements is a constant intrinsic property of the proportional counter over all the elements. J. HUGHES

537.542 : 539.185.08

9326. A multiple-wire proportional counter for fast neutron detection. C. R. SUN AND J. R. RICHARDSON. *Rev. sci. Instrum.*, **25**, 691–4 (*July*, 1954).

A cylindrical chamber, 8·5 in. in length and 8·5 in. in diameter, containing two sets of parallel multiple-wire grids has been built and operated as a proportional counter for fast neutron detection. The collecting wires are 0·001 in. in diameter. Filled with pure CH_4 at about atmospheric pressure and operated at 3400 V, it serves to detect neutrons up to 10 MeV, with an average efficiency of 0·17%. The energy distribution of neutrons from 0·3 to 3 MeV can be estimated. The multiple-wire counter is completely insensitive to γ-radiation under these operating conditions. This instrument has been used to make a survey of fast neutrons around the U.C.L.A. cyclotron. At higher pressures the instrument can presumably be used to measure neutron spectra of higher energy. A.

537.542

9327. The response of a sodium iodide scintillation counter to 18 MeV γ-radiation. J. G. CAMPBELL AND A. J. F. BOYLE. *Austral. J. Phys.*, **7**, 284–7 (*June*, 1954).

The probability distribution of ionization energy in a sodium iodide crystal 2·5 cm long by 2·5 cm dia. due to the absorption of 18 MeV quanta has been calculated taking account of side escape of electrons from the crystal due to multiple scattering. The results confirm the conclusions of the authors' earlier work [Abstr. 6109 (1953)]. A.

537.542

9328. Scintillation response of anthracene to soft X-rays. J. B. BIRKS AND F. D. BROOKS. Letter in *Phys. Rev.*, **94**, 1800–1 (*June* 15, 1954).

Theoretical expectations indicate a different response for excitation of anthracene by external electrons from that for internal electrons (X-ray excitation). Experimental results are given showing this difference and the quantitative agreement with theory for the 1–25 keV energy range. G. F. J. GARLICK

537.542

9329. The mechanism of spark counters. D. BLANC. *J. Phys. Radium*, **15**, 483–9 (*June*, 1954) *In French.*

A brief history of the spark counter is followed by discussion of its mechanism and efficiency in the various forms. Dead time, resolution time and "plateau" are discussed. Practical information is given on counter design but associated circuitry is not included. G. F. J. GARLICK

537.542

9330. On non-focused Cherenkov effect counters. M. MANDÒ. *Nuovo Cimento*, **12**, 5–27 (*July*, 1954) *In Italian.*

The properties of non-focused counters are investigated, especially in view of their possible applications in cosmic-ray work. Attention is mainly concentrated on optical collection efficiency and its uniformity, time of response (defined as the rise time of the electrical pulse produced on the photocathode), large sensitive area and ability to distinguish between particles travelling in exactly opposite directions (the "antidirectional property" peculiar to Cherenkov detectors, owing to the intrinsic anisotropy in the emission of the Cherenkov light). Cherenkov detectors are classified into three classes according to the optical properties of the walls, namely specular, diffusing and mixed. For each class a typical geometry is discussed in detail, while reasonable generalization of results is also discussed. The main conclusions are: (*a*) properly designed specular detectors, while easily exhibiting good "antidirectional properties" and occasionally high collection efficiency, can hardly ensure uniformity of response with a sensitive area which is large compared to that of the photocathode; (*b*) good "antidirectional properties" and uniformity of response can be best achieved with mixed counters, the optical efficiency being then uniformly low (not lower, however, than the efficiency of specular counters for particles impinging under the less favourable incidence); the often employed diffusing cone, however, does not by any means appear to be the best solution; (*c*) diffuse counters allow the largest area for a given optical efficiency and vice versa; they ensure absolute uniformity of efficiency, but obviously do not show any "antidirectional property"; they also show considerably longer time of response, with respect to other types, but this time may be of the order of some 10^{-8} sec for a 30 cm diameter counter, which might be good enough for many purposes; oblong forms are not advisable for this type. A.

537.542 : 539.18.

9331. An instrument for measuring the decay of mu-mesons. H. S. HANS. *Indian J. Phys.*, **28**, 93–102 (*Feb.*, 1954).

An electronic instrument designed to study many problems connected with the decay of μ-mesons is discussed in detail. Special coincidence circuits, which differ from ordinary coincidence circuits in the fact that the output pulse from the special coincidence corresponds to the first input pulse, rather than to the last one, are used for recording the incoming mesons and the decay electrons. Many channels of delayed coincidences are used so that several points on the decay curve can be obtained simultaneously. A.

537.542

9332. Detection of ionizing particles by means of a diffusion chamber. P. E. ARGAN, N. D'ANGELO AND A. GIGLI. *Ricerca sci.*, **24**, 1006–11 (*May*, 1954) *In Italian.*

A report on the design and working characteristics of a diffusion chamber recently built at the Institute of Physics, Rome. The preliminary results of a theory of this instrument are described, in which the influence of a given temperature distribution on the side walls of the chamber on the sensitive layer is considered. A.

537.542

9333. Some practical aspects of diffusion cloud chamber operation. M. H. ALSTON, A. V. CREWE AND W. H. EVANS. *Rev. sci. Instrum.*, **25**, 547–51 (*June*, 1954).

Experimental problems which arise in the operation of diffusion cloud chambers are discussed. Particular attention is paid to methods of cooling the base of the chamber and design features of this type of chamber. Some of the limitations of the instrument are mentioned, and there is a discussion of symptoms which can arise when the conditions of operation are defective. A.

537.543 : 621.385.16

9334. A study of the properties of static space charges of the magnetron type. J.-L. DELCROIX. *Ann. Phys.* [*Paris*] **9**, 269–321 (*May–June*, 1954) *In French.*

A comprehensive theory is given using a similar treatment to that of Hartree and achieving similar results. An experimental study indicates that inclination of the magnetic field leads to an increase in the cut-off current and brings about a transition from Brillouin flow to a double-stream state. It is concluded on the basis of further theory that if at any time both a Brillouin state and a double-stream state are possible it will be the latter which is established. A magnetron with circular magnetic field is treated.

G. D. SIMS

537.543 : 621.385.2.014

9335. Test of Langmuir's three halves power law, deviations due to β^2-factor and secondary emission. P. L. WALRAVEN. *Appl. sci. Res. B*, **3**, *No.* 6, 393–9 (1954).

According to theory a small correction (the so-called β^2-factor) should be applied to Langmuir's law for the electron current in a cylindrical high vacuum diode. To test this, a method was developed for eliminating the potential drop along the hot cathode filament. The accuracy thus obtained disclosed an unexpectedly large deviation of the coefficient in Langmuir's formula from its theoretical value. This discrepancy is most probably due to the influence of secondary emission of the anode. It is possible to correct for this influence in a simple way by introducing an "effective reflection coefficient" of the anode. For anode voltages in the range of 1–30 V, values of this coefficient of 14% for tantalum and of 5·5% for aquadag give a good description of the experimental results. In a similar way the well known (ξ, η)-tables of Langmuir should be corrected if they are to represent the real situation. A.

IONIZATION . THERMIONICS 537.56/.58

537.56 : 536.23 : 533.16

The viscosity and thermal conductivity of a completely ionized gas. *See Abstr.* 8974

537.56 : 537.533

9336. Ionization by means of strong electric fields. F. KIRCHNER. Note in *Naturwissenschaften*, **41**, *No.* 6, 136 (1954) *In German.*

A brief extension of previous work on field emission microscopes [Abstr. 2468 (1954)]. The mechanism of emission due to spontaneous ionization of adsorbed gas atoms on metallic points is considered.

C. G. MORGAN

537.561 : 539.132

9337. Adiabatic correlations for the formation of methyl ions from methane and its derivatives by electron impact. C. A. MCDOWELL. *Trans Faraday Soc.*, **50**, 423–30 (*May*, 1954).

Knowing the geometry and probable molecular orbital formulae for methane and some of its derivatives, it is possible by the application of the Franck–Condon principle to decide which electronic-vibrational (vibronic) states of the molecular ions are likely to be formed by the impact of electrons with known energy. It is then possible to apply group theory methods to derive adiabatic correlations between the different vibronic states of the parent molecular ions and the ground vibronic state of the methyl ion. Since the appearance potentials for the methyl ion from these molecules are known it is thus possible to identify the dissociation limits of some of the important vibronic states of the parent ions derived from this series of compounds. A.

537.561 : 539.132

9338. Studies of ionization efficiency. IV. The electron spectra of some simple molecules. J. D. MORRISON. *J. chem. Phys.*, **22**, 1219–23 (*July*, 1954).

For Pt III, see Abstr. 556 (1954). The second differential ionization efficiency curves for a number of simple molecule-ions have been recorded using a new technique of measurement. A close correlation can be drawn between the results and spectroscopic data, confirming in most respects the interpretation of ionization efficiencies made in Pt III. It proves possible to detect the presence of upper ionic states at energies corresponding to extreme ultraviolet radiation. The factors which affect line shape in optical spectra are shown to apply also to the second differential ionization efficiency curves, which are termed electron spectra. It is shown that the ionization efficiency curves for fragment ions can also be interpreted in a similar manner, and the types of electron spectra to be expected for different kinds of dissociation processes are discussed. A.

537.562

9339. Relative ionization yields for fission fragments in various gases. L. O. HERWIG AND G. H. MILLER. *Phys. Rev.*, **95**, 413–17 (*July* 15, 1954).

The ionizations resulting from U^{238} fission have been measured in He, Ne, A, Kr, N_2, A + 3% CO_2, and A + 5% N_2. Comparison of these values with those obtained for α-particles in the same chamber fillings permit the calculation of ionization defect differences. It was found that about half of the 7-MeV defect previously ascribed to argon–CO_2 mixtures was due to CO_2. Nitrogen and krypton exhibited relatively large defects. No significant difference was observed between argon and helium. Several possible explanations for this are suggested and discussed. A.

537.562 : 539.165

Absorption of tritium beta particles in hydrogen and other gases. *See Abstr.* 9561

537.564

9340. Ionization and excitation of mercury vapour by [potassium] positive ion impact. R. M. CHAUDHRI, C. M. ASLAM AND S. U. HASAN. Letter in *Nature* [*London*] **173**, 1186 (*June* 19, 1954).

The radiations produced by impacting ions of 250–900 eV energy were studied by means of a Geiger counter with a highly photo-sensitive cathode. The results indicate that the radiations observed resulted largely from recombination following ionization of the Hg atoms by ion impact. J. DUTTON

537.564

9341. The dissociation and ionization of molecules in collisions with atoms. E. LINDHOLM. *Z. Naturforsch.*, **9a**, 535–46 (*June*, 1954) *In German.*

A brief description of the apparatus is given, and followed by detailed results for the molecules CO_2, H_2O, H_2S, NH_3, CH_4 and N_2O. Each of these molecules was studied with some 15 or so ions, and the relative abundances of the main products are tabulated, with appearance potential data, etc.

J. D. CRAGGS

537.564

9342. Inelastic collisions between heavy particles. II. Contributions of double-transitions to the cross sections associated with the excitation of hydrogen atoms in fast encounters with other hydrogen atoms. D. R. BATES AND G. W. GRIFFING. *Proc. Phys. Soc.* [*London*] *A*, **67**, 663–8 (*Aug.*, 1954).

For Pt I, see Abstr. 2533 (1954). Born's approximation is used to calculate the cross-sections of the processes

$$H(1s) + H(1s) \rightarrow H(2s \text{ or } 2p) + H(2s,\ 2p,\ 3s,\ 3p,\ 3d \text{ or } C)$$

where C represents the continuum. The results are presented mainly in graphical form. It is found that these double-transition collisions are together much more effective at high impact energies than are simple single-transition collisions such as

$$H(1s) + H(1s) \rightarrow H(2s \text{ or } 2p) + H(1s).$$

An asymptotic formula for the total inelastic cross-section is also obtained. A.

537.564

9343. The second Born approximation in inelastic collisions of electrons with atoms. W. ROTHENSTEIN. *Proc. Phys. Soc.* [*London*] *A*, **67**, 673–83 (*Aug.*, 1954).

The second approximation in Born's theory of collisions is worked out for the excitation of the $2p$ state of hydrogen and of the 2^1P state of helium from the corresponding ground states by electron impact. The method is not applicable to electron energies too close to the threshold. The correction introduced by the second approximation, which reduces the intensity of the small angle inelastic scattering and the total inelastic cross-section by an amount increasing as the electron energy decreases, is of the correct

sign and about the right magnitude, in the energy range to which it is applicable, to provide an explanation of the discrepancies between calculated and observed cross-sections for excitation of optically allowed transitions. A.

537.583

9344. Oxide cathodes in accelerating fields. P. N. Daykin and D. A. Wright. Note in *Proc. Phys. Soc.* [*London*] *B*, **67**, 439–41 (*May*, 1954).

For background, see Abstr. 2799 (1952). It has been pointed out that, as a result of one of the equations being only approximate, two of the curves given are inaccurate and also two of the values in δx_0 (0·29 and 0·12). The problem has been carried further by Shindo [Abstr. 3671 (1952), 558 (1954)]. Some cross checks on Shindo's solution are discussed.

A. H. W. BECK

537.583 : 539.27

9345. Thermionic emission and electron diffraction from thin films of barium oxide. P. N. Russell and A. S. Eisenstein. *J. appl. Phys.*, **25**, 954–61 (*Aug.*, 1954).

A high-vacuum, sealed-off glass, electron diffraction tube was developed for observing the physical structure of evaporated BaO films on a nickel substrate. Simultaneously, measurements of thermionic emission could be made. The thermionic activity of the deposited film increased until approximately 20 monolayers (measured using a radioactive tracer technique) had been laid down, and no further increase was found up to 50 monolayers. This emission density (0·4 A/cm² at 1000°K) is comparable with that obtainable from sprayed oxide coatings. With the receiver at less than 450°K the oxide film showed an amorphous structure. With the receiver at 800°K the film was crystalline and was believed to exist in clumps. This crystalline structure became amorphous if the films were heated to 1070°K and this form persisted as the oxide film was removed by evaporation. The relation of the thermionic emission from thin BaO films to that from sprayed oxide cathodes is discussed. A.

537.583 : 621.385.032.216

9346. Noise mechanisms in oxide-coated cathodes. A. van der Ziel. *Physica*, **20**, 327–36 (*June*, 1954).

A critical review is given of a number of mechanisms explaining flicker noise in vacuum tubes. It is shown that only Schottky's emission centre theory and a new depletion layer theory can account for the observed noise. The former theory most likely applies to W, Th-W and L-cathodes, whereas the latter theory seems to give the right order of magnitude of noise for oxide-coated cathodes. A.

COSMIC RAYS 537.591

537.591

9347. Progress in cosmic ray physics. Volume 2. Edited by J. G. Wilson. *Amsterdam*: *North-Holland Publishing Co.*, xi + 322 *pp.*

Review in *Brit. J. appl. Phys.*, **5**, 301–2 (*Aug.*, 1954).

537.591.1

9348. Propagation of the cosmic radiation through interstellar space. S. Hayakawa and S. Kobayashi. *J. Geomagn. Geoelect.*, **5**, 83–93 (*Nov.*, 1953).

Various theories on the origin of the cosmic radiation are critically surveyed. Expected phenomena resulting from the galactic origin theory in which charged cosmic rays are trapped by the galactic magnetic field are discussed with special regard to the secondaries due to the collisions with interstellar hydrogen. Electrons through the decay process $\pi \rightarrow \mu \rightarrow e$ are then expected to amount to 3 to 9% of the total intensity, depending upon the magnetic field strength in our Galaxy. An alternative hypothesis that the cosmic radiation propagates in a straight manner is also examined. It is proposed that this may be tested by observing primary photons, resulting from the decay process $\pi^0 \rightarrow 2\gamma$, which could be several % of the total radiation at low latitudes. A.

537.591.1

9349. Note on the positive temperature coefficient of the cosmic radiation. J. C. Barton. Note in *Proc. Phys. Soc.* [*London*] *A*, **67**, 637–9 (*July*, 1954).

The positive temperature coefficient due to the decay of π-mesons is estimated and it is shown that good agreement is obtained between the predicted value and the experimental value when the atmospheric temperature variation up to a height of 30 km is taken into account. H. ELLIOT

537.591.1

9350. Magnetic orientation of stratosphere sondes. J. Heidmann. *J. Phys. Radium*, **15**, 344–51 (*May*, 1954) *In French.*

Describes an arrangement for maintaining nuclear emulsion plates, carried by balloons, orientated in a fixed direction. The apparatus is floated in liquid and the orientation is kept constant by means of magnets. Provision is made for recording the direction of the sun as a check and the weight of the equipment is 5 kg. H. ELLIOT

537.591.1

9351. Primary heavy nuclei. T. H. Stix. *Phys. Rev.*, **95**, 782–92 (*Aug.* 1, 1954).

Primary cosmic-ray nuclei of $z \geqslant 2$ were observed in a balloon-borne cloud chamber. The chamber was triggered by events with ionization loss $\geqslant 6$ minimum in each of three proportional counters, arranged in a telescope. Proportional counter pulse amplitudes were recorded by a neon bulb system. Two Skyhook daytime balloon flights at geomagnetic latitude 41° maintained average altitudes of 17·6 and 14·3 g/cm². In the 0·77 hours sensitive time, in two flights, there were observed in the cloud chamber (charge determined from both cloud chamber and proportional counter data) 3–5 Li, 1 Be, 0 B and 21 $z \geqslant 6$ nuclei. A primary flux of $10 \cdot 2^{+4 \cdot 5}_{-3 \cdot 4}$ particles per m² sec sterad is found for the $z \geqslant 6$ nuclei. An unusually large fraction of this group is indicated to be heavier than oxygen. The primary flux of Li, Be and B nuclei is found to be 5^{+32}_{-5} % of the primary flux of $z \geqslant 6$ nuclei, from which it is concluded that heavy nuclei have traversed less than 7 g/cm² interstellar hydrogen [$= (4/n) \times 10^6$ light years, where n = number of H atoms per cm³]. The

proportional counter data alone showed a $14 \pm 16\%$ decrease in intensity of particles of $z > 8$ from morning to afternoon. A.

537.591.1

9352. Cosmic-ray neutrons in water at an altitude of 10 600 feet. M. J. SWETNICK. *Phys. Rev.*, **95**, 793–6 (*Aug.* 1, 1954).

The neutron component of the cosmic radiation in the first 50 cm layer of water adjacent to the surface of a mountain lake, located at an altitude of 10 600 ft, was studied with the aid of a tray of ten enriched boron trifluoride filled counters connected in parallel. A measure of the thermal neutron intensity was obtained by alternately shielding the tray of counters with tin and cadmium of equal g cm^{-2}. A transition region was found to exist between the surface and the 30 cm level wherein the thermal neutron intensity decreased rapidly with depth. Below the 30 cm level, the thermal neutron intensity was found to be almost constant over an interval of 20 cm. The neutron production rate and thermal neutron flux, just below the transition region, were found to be $4{\cdot}6 \times 10^{-5}$ neutrons g^{-1} sec^{-1} and about $4{\cdot}3 \times 10^{-4}$ thermal neutrons cm^{-2} sec^{-1}, respectively. A.

537.591.15

9353. Production frequency of neutral *pi*-mesons in high energy interactions. D. LAL, Y. PAL AND B. RAMA. *Proc. Indian Acad. Sci. A*, **39**, 127–31 (*March*, 1954).

The ratio of neutral π-mesons to charged shower particles produced by interactions in the energy range 50–250 BeV/nucleon has been determined using a stripped emulsion block flown at 75 000 ft. The value obtained is $N_{\pi^0}/N_s = 0{\cdot}40 \pm 0{\cdot}08$. An upper limit of 0·25 is given for the ratio of the number of K-mesons and hyperons to the number of charged π-mesons. H. ELLIOT

537.591.15

9354. On relativistic particles in high energy showers. B. RAMA. *Proc. Indian Acad. Sci. A*, **39**, 162–4 (*April*, 1954).

Showers of primary energy between 50 and 1000 BeV, observed in a block of stripped nuclear emulsions, have been used to determine the interaction cross-section for shower particles in the emulsion and also the ratio of neutral π-mesons to charged shower particles. The values found are, respectively, $29{\cdot}3 \pm 7{\cdot}6$ cm and $0{\cdot}40 \pm 0{\cdot}08$. H. ELLIOT

537.591.15

9355. Penetrating showers from lead and from carbon. M. DEUTSCHMANN. *Z. Naturforsch.*, **9a**, 477–88 (*June*, 1954) *In German.*

Measurements on 854 showers which begin in a cloud chamber with several lead strips and one carbon block are discussed. The energy going into the π^0-component is estimated by enumeration of electron tracks [see abstract following]. It is found that—contrary to the assumptions of the usual cascade theory, which assumes that a single electron or photon begins the cascade—several π^0-mesons are produced, each disintegrating into two photons. The spectrums of the shower energy and π^0-component are measured. G. E. BROWN

537.591.15

9356. Numerical calculations in cascade theory. Energy determination from π^0-mesons. K. OTT. *Z. Naturforsch.*, **9a**, 488–94 (*June*, 1954) *In German.*

The number of electrons in an electron-photon cascade in lead is calculated as a function of distance from the point of origin of the shower for primary energies in the range 0·3 to 300 GeV. The theory can be applied to the production of cascades beginning from a photon which produces an electron, and, especially, those begun by a π^0-meson decaying into two photons, etc. [see preceding abstract]. In addition, the photon spectrum of a bremsstrahlung type produced in electron cascades is discussed and compared with experiment. G. E. BROWN

537.591.15

9357. Core structure in soft component showers. H. S. GREEN AND O. BERGMANN. *Phys. Rev.*, **95**, 516–21 (*July* 15, 1954).

Methods are devised for the solution of the integro-differential equations for the evolution and spread of the soft component of the cosmic radiation, avoiding approximations made in earlier work. The behaviour of the radial and angular distribution functions is analysed near their origins and coefficients are found in each case for the δ-type singularity arising from particles, which together with their ancestors have suffered no Coulomb scattering. In the case of the radial-distribution function for electrons only, there are additional r^{-1} and $\log r$ singularities. The contribution of these singularities is compared with that of the overall distribution by rough numerical computations. Expressions are given for the overall distribution functions that are suitable for machine computations. A.

537.591.2

9358. The integral and differential range spectra of sea-level mesons. A. J. DYER. *Austral. J. Phys.*, **7**, 49–56 (*March*, 1954).

The differential and integral range spectra of the hard component of cosmic rays in water and lead have been determined up to a thickness of 1500 g cm^{-2} of water, and 2800 g cm^{-2} of lead. The differential results indicate that there is no anomaly with an intensity greater than 5% in the differential momentum spectrum in the region below 4 BeV/c. A comparison of the integral range and momentum spectra supports the energy loss data of Halpern and Hall in preference to those of Bethe and Block in the case of water. No such distinction of the theories is possible in the case of lead and, although the integral absorption curve in lead agrees with that obtained by Heyland and Duncanson [Abstr. 3413 (1953)], there is an unexplained discrepancy between experiment and theory. The intensity of knock-on showers as a function of thickness of water absorber has also been determined. A.

537.591.3

9359. The barometer coefficient and air mass effects on cosmic rays at Macquarie Island. R. M. JACKLYN. *Austral. J. Phys.*, **7**, 315–21 (*June*, 1954).

The changes in cosmic-ray intensity associated with the passage of weather fronts over the observing

station [e.g. Abstr. 5926 (1950)] have been investigated, using data from Macquarie Island. The effects can be explained in terms of the different way in which the height of the production layer for mesons varies with surface pressure for warm moist and cold dry air masses. The barometer coefficients found for these air masses are respectively $-0{\cdot}120 \pm 0{\cdot}058\%$ per mb and $-0{\cdot}220 \pm 0{\cdot}041\%$ per mb for the penetrating component. These results indicate that the frequently observed fluctuations in short-term barometer coefficients may be traceable to changes in air mass types. A.

537.591.3

9360. Ionization chamber measurements at 10 600 feet of the absorption of the *N* component in carbon and hydrocarbon. R. H. Rediker. *Phys. Rev.*, **95**, 526–31 (*July* 15, 1954).

A detector consisting of a lead-shielded ionization chamber with Geiger counters above and below the chamber is described. The charged *N* component of energy of several tens of BeV is detected. The absorption of the charged *N* component in carbon is much smaller than that predicted from the absorption in air. This phenomenon may be explained by the fact that π-mesons or other unstable particles which are produced in nuclear interactions can give rise to further nuclear interactions. Approximate values for the interaction mean free path of *N* rays in carbon have been obtained. These values depend on the number of shielded counters below the ionization chamber which are struck. For zero counters discharged, the mean free path is 136 ± 12 g cm^{-2} and seems to decrease as the requirement on the number of shielded counters struck is increased. The interaction mean free paths in carbon are compared to previous results in lead. The absorption of the *N* component in oil indicates a cross-section of the hydrogen nucleus much smaller than that corresponding to the range of nuclear forces. Events with large pulses from the ionization chamber or with multiple discharge of shielded counters below the chamber are more likely to be associated with the nucleonic component of extensive air showers. A.

537.591.5

9361. Some analysis on the oblique incident cosmic ray intensity. M. Wada, I. Kondo and Y. Miyazaki. Note in *Rep. Ionosphere Res. Japan*, **5**, 103–6 (*June*, 1951).

537.591.5

9362. Latitude effect of the intensity decrease in the cosmic-ray storm. S. Yoshida and Y. Kamiya. *J. Geomagn. Geoelect.*, **5**, 136–40 (*Dec.*, 1953).

The latitude effect of the cosmic-ray decrease associated with the magnetic storm was determined from the data obtained in 13 periods of observation at various stations over the world. The result was in accordance with Nagashima's electric field theory. A.

537.591.5

9363. The world-wide variation of cosmic ray intensity by the electro-magnetic field. K. Nagashima. *J. Geomagn. Geoelect.*, **5**, 141–67 (*Dec.*, 1953).

The intensity variations of the ionizing and neutron components produced by the variation of the static electric field are calculated in detail, extending over various altitudes and latitudes. By comparing these calculations with observations, it can be concluded that this electric field hypothesis may be used to explain the phenomenon of the world-wide variations in intensity pointed out recently by various authors. It may be possible for the diurnal variation of cosmic-ray intensity to be produced by an electric field not derived from potential. A.

537.591.5

9364. Distribution of cosmic-ray unusual increase over the earth. Y. Sekido and S. Yoshida. *Rep. Ionosphere Res. Japan*, **7**, 147–55 (*Dec.*, 1953).

Cosmic-ray unusual increases were observed at various stations with various types of equipment, and were published in various units of time interval. These data were reduced into a standard scale, to see their distribution over the earth. Thus, a simple image of the latitude effect and the local time effect was obtained. The local time of maximum incidence is at about 3 hr–8 hr, and the geomagnetic latitude of maximum incidence seems to be at about 60°–80°. A.

537.591.5

9365. On the interpretation of the diurnal variation of cosmic rays. E. Å. Brunberg and A. Dattner. *Tellus*, **6**, 73–83 (*Feb.*, 1954).

The recorded data of diurnal variation of the cosmic-ray intensity are analysed. By using the known deflection of the cosmic-ray particles in the geomagnetic field [Brunberg and Dattner (1953)] and under an assumption of an anisotropy in the primary cosmic radiation, it is shown that the momentum of the primary radiation and the direction of the anisotropy can be determined. The anisotropy is explained as an effect due to the distribution of cosmic-ray particles rotating with the solar magnetic field as suggested by H. Alfvén. The diurnal variation is ascribed to the earth's rotation in the anisotropic distribution of cosmic-ray particles. The theoretical amplitude of this variation is calculated. A.

537.591.5

9366. The zenith-angle variation of cosmic-ray meson intensity. A. Beiser. *J. geophys. Res.*, **59**, 253–5 (*June*, 1954).

The observed $\cos^k$ zenith-angle variation of μ-meson intensity at low elevations is derived on the basis of a p^{-n} meson momentum spectrum at production. It is found that $k = n - 1$ to a good approximation, in agreement with experimental evidence. The region of validity of this relationship is discussed. A.

537.591.5

9367. Cosmic radiation at very high altitudes near the geomagnetic equator. M. A. Pomerantz. *Phys. Rev.*, **95**, 531–7 (*July* 15, 1954).

During an extensive series of balloon-flights near the geomagnetic equator in India, intensity-depth curves have been obtained with the standard quadruple coincidence counter trains, containing various thicknesses of interposed absorber (4·0 cm, 7·5 cm and 17·7 cm of Pb), previously utilized at high latitudes. A rather pronounced difference occurs between the two stations at Aligarh, Uttar Pradesh ($\lambda = 18°$ N) and Bangalore, Mysore ($\lambda = 3°$ N). The primary flux values, extrapolated to the "top of the atmosphere" from data obtained with instruments

containing 7·5 cm of Pb, are $0{\cdot}032 \pm 0{\cdot}001$ and $0{\cdot}024 \pm 0{\cdot}001$ cm^{-2} sec^{-1} sterad^{-1}, respectively. A maximum appears in all of the curves, and the general features, as well as the absorption characteristics of the cosmic rays in the upper atmosphere, are in accord with expectation. The effective absorption length in lead, approximately 290 g/cm^2, remains unchanged when the geomagnetic cut-off energy of the primary protons is increased from 1·4 BeV to 14·2 BeV. The intensity of mesons having energies exceeding 260 MeV is determined from the data by invoking Messel's theory of the nucleon cascade, and this yields results which are in excellent agreement with the available experimental facts. The primary magnetic-rigidity spectrum averaged over the range 2·1 BV to 15·4 BV is $N(>pc/Ze) = 0{\cdot}68(1 + pc/Ze)^{-1\cdot2}$, based upon the present measurements at 52° N and 3° N. However, the data recorded within the equatorial region require a higher value of the corresponding exponent in the differential distribution if the usual assumptions are valid. This effect may be attributable to an irregularity in the primary spectrum, contributions from trapped orbits and albedo, or local magnetic anomalies. The ratio of intensities in the horizontal and vertical directions at high altitudes is practically equal at 52° N and 3° N, although it would have been expected to increase near the equator in view of the decrease previously observed north of 52°. A.

537.591.8

9368. On the interaction mean free path of ionizing particles emitted in nuclear explosions produced by cosmic rays. C. Castagnoli, C. Franzinetti and A. Manfredini. *Ricerca sci.*, **24**, 792–8 (*April*, 1954) *In Italian.*

An investigation undertaken to measure the interaction mean free path λ in photographic emulsion, due to ionizing particles produced in nuclear explosions of great energy. These particles have been divided into three groups according to their ionizing power g. The results can be summarized as follows: (1) for particles of an ionizing power $g \leqslant 1{\cdot}5\, g_{\min}$, $\lambda_S = 236 \pm 48$ g/cm^2; (2) for particles of an ionizing power $1{\cdot}5\, g_{\min} \leqslant g \leqslant g_{\min}$, $\lambda_G = 104 \pm 16$ g/cm^2; (3) for particles of an ionizing power $g \leqslant 5\, g_{\min}$, $50 \leqslant \lambda_N \leqslant 100$ g/cm^2. In this case the value of λ_N could not be determined with more precision as it is dependent on the distribution function of the ranges of the particles, and this distribution is known only approximately. A.

537.591.8

9369. Delayed disintegration of heavy fragments. F. A. Brisbout and V. D. Hopper. *Austral. J. Phys.*, , 352–4 (*June*, 1954).

Photographs of two examples of heavy particles with $Z = 3$ or 4 and $Z = 2$, respectively, which are produced in a star and later disintegrate, are presented and the data on momenta, etc., are discussed.

G. E. BROWN

537.591.8

9370. A clarification of the "*T*-tracks" in nuclear emulsions. A. De Marco and A. Milone. *Nuovo Cimento*, **12**, 99–102 (*July*, 1954) *In Italian.*

To clear up the problem of the so-called "*T*-tracks," it is interesting to know the maximum value R_0 of the distances r between a black track ending in the emulsion and a minimum track, when the association between the two tracks is a surely established physical event. This maximum value was determined in the case of $\mu \rightarrow e$ decays and it was found that 90% of the distances r are contained in the range 0–0·6 μ. The distribution of the distances r in the case of the *T*-tracks was compared in the range 0–R_0 with the experimentally determined distribution of random coincidences. The close similarity of the two distributions shows that no evidence exists of the occurrence of non-casual *T*-tracks. A.

537.591.8 : 539.155.2

Effects of cosmic radiation on terrestrial isotope distribution. *See Abstr.* 9534

537.591.8 : 539.18

9371. Heavy unstable particles in stripped emulsions. J. Crussard, M. F. Kaplon, J. Klarmann and J. H. Noon. Letter in *Phys. Rev.*, **95**, 584 (*July* 15, 1954).

Gives details of measurements on four *k*-type decays, one τ-decay, one $\Lambda^{\pm}$-decay and the decay of an excited fragment with $4 \leqslant Z \leqslant 6$. All these events were observed in emulsions flown at balloon altitudes. H. ELLIOT

537.591.8 : 778.34

9372. Cosmic ray phenomena at minimum ionization in a new nuclear emulsion having a fine grain, made in the laboratory. P. Demers. *Canad. J. Phys.*, **32**, 538–54 (*Aug.*, 1954).

The preparation of a silver bromide emulsion in the form of baseless sheets and their use in thick homogeneous stacks are described. In these sheets, a suitable development brings out minimum ionization tracks with a grain-diameter 0·1 to 0·2 μ, and a linear grain density of 15 per 100 μ. The sequence of observations which led to the positive identification of minimum tracks is discussed. Short recoils and δ-rays are visible, and excellent discrimination is available at all ionizing powers. The influence of grain size on fog is analysed. Several cosmic-ray phenomena containing minimum tracks are presented: single tracks, hard showers, $\pi\mu e$ events, and an electron pair. Distortion is very small, and it is shown that the small grain size renders feasible better scattering measurements on higher-energy particles. With this emulsion, nearly every possible measurement should become feasible with greater accuracy. A.

MAGNETISM 538

538.082.74 : 621.317.4.029.5

9373. Discussion of current-sheet approximations in reference to high-frequency magnetic measurements. B. Kostyshyn and P. H. Haas. *J. Res. Nat. Bur. Stand.*, **52**, 279–87 (*June*, 1954).

The problem of violations of thin, uniform current-sheet assumptions in toroidal coils of rectangular cross-section is investigated from the viewpoint of h.f. magnetic measurements. The errors resulting by neglecting leakage flux and by assumptions concerning the location of effective current sheets are investigated experimentally as a function of permeability,

core dimensions, wire spacing, and wire size. The adequacy of at least two attempts at calculations of these errors is discussed and conclusions are drawn on the limitations of measurement at h.f. on toroidal coils. A.

538.114

9374. Spherical model of an antiferromagnet. B. S. Gourary and R. W. Hart. *Phys. Rev.*, **95**, 676–86 (*Aug.* 1, 1954).

The specialization technique is adapted to the calculation of the partition function of a body-centred cubic lattice of spins with isotropic antiferromagnetic interactions between nearest neighbours and between second-nearest neighbours. Two transition points may be obtained. The usual Curie point transition from the paramagnetic state to the antiferromagnetic state (caused by the sticking of the saddle point) leads to an antiferromagnetic state with ordering either of the first kind or of the second kind, depending on the value of the ratio of the second-nearest neighbour interaction to the nearest-neighbour interaction. In addition a first-order transition from one kind of ordering to the other can occur if the ratio of the interactions varies with the specific volume in such a way that it moves through a critical value. Mathematically, this transition occurs because the largest eigenvalue of the interaction matrix becomes triply degenerate at the temperature at which the ratio of the interactions attains the critical value. The long-range order is measured in terms of long-range order parameters, which are closely related to the sublattice magnetizations. The analogue of the perpendicular susceptibility is also calculated. Qualitative agreement with the molecular field theory is obtained for all those properties of the model which depend on the long-range order. In contrast to the molecular field theory, this model should give valid predictions for quantities depending on short-range order. A.

538.12

9375. The field of a magnetic dipole in the presence of a conducting sphere. H. W. March. *Geophysics*, **18**, 671–84 (*July*, 1953).

Formulae are derived for the components of the distorted field of a magnetic dipole in the presence of a conducting sphere in a homogeneous medium. In the method employed the field is resolved into two partial fields for the first of which the radial component of the magnetic vector vanishes and for the second of which the radial component of the electric vector vanishes. From the general formulae approximate formulae are derived for the field components in the special case in which the conductivity of the medium is low, the radius of the sphere is not too large and both the dipole and the observer are in the vicinity of the sphere. These approximate formulae are within limits applicable to the problem of locating a spherical body of ore buried in a mass of rock. A.

538.12 : 523.75

9376. Twisted magnetic fields in conducting fluids. J. W. Dungey and R. E. Loughhead. *Austral. J. Phys.*, **7**, 5–13 (*March*, 1954).

The formation of loops in the lines of force of a twisted magnetic field confined within a cylinder of radius R, first suggested by Alfvén [Abstr. 8442 (1950)], is discussed by the method of normal modes. The model first becomes unstable with respect to modes which do not lead to the formation of loops. Ignoring this, the condition obtained for loop formation is that the pitch of the twisted field be less than πR. The velocity of Alfvén waves in this model is also discussed. A.

538.221

9377. On the g-factor and H_i [internal field] of nickel ferrite-aluminate. Y. Torizuka, Y. Kojima, and T. Fujimura. Note in *J. Phys. Soc. Japan*, **9**, 298–9 (*March–April*, 1954).

Reports results of room-temperature resonance absorption measurements at frequencies 19·23 and 28·85 kMc/s on the substances $NiO.Fe_{2-x}Al_xO_3$. The size-effect is eliminated for the spherical samples. Values of g and H_i, where $\omega_0 = (e/2mc)g(H + H_i)$, are given for a range of values of x. It was found that $H_i \simeq 300$ oersted for $x < 0{\cdot}72$, $H_i = 0$ for $x > 0{\cdot}72$; at this composition the magnetization of the ferrite, also measured, suffers a reversal. See also Abstr. 2590 (1954). E. P. Wohlfarth

538.221

9378. Complex initial magnetic permeability of iron from 0 to 7000 Mc/s. J. Benoit and E. Naschke. *C.R. Acad. Sci.* [*Paris*] **238**, 2292–4 (*June* 14, 1954) *In French.*

Describes results of high-frequency permeability measurements on a specimen of Armco iron which is made up of large elementary domains. After an annealing treatment at 800°c results are obtained which are suitable for comparison with theoretical results obtained by Néel [Abstr. 3652 (1954)] for boundary movement processes. The agreement is good for the real component of the permeability. E. P. Wohlfarth

538.221

9379. Influence of Weiss domain width on the permeability of iron between 0 and 7000 Mc/s. J. Benoit and E. Naschke. *C.R. Acad. Sci.* [*Paris*] **238**, 2404–5 (*June* 21, 1954) *In French.*

A continuation of previous work (preceding abstract). Values of the domain width of Armco iron specimens annealed at different temperatures between 500° and 1220°c were deduced from complex permeability measurements using formulae developed by Néel [Abstr. 3652 (1954)], the values ranging from about 2·5 to 8·5 μ. The variation of the real component of the permeability with annealing temperature was obtained at different frequencies; at high frequencies the influence of domain width on permeability becomes progressively less important. E. P. Wohlfarth

538.221

9380. Anhysteretic magnetization of Alcomax III. J. E. Gould and M. McCaig. Note in *Proc. Phys. Soc.* [*London*] *B*, **67**, 584–6 (*July*, 1954).

Describes measurements of the anhysteretic curve in steady fields up to 800 oersted with peak a.c. fields 1500 oersted or more. The anhysteretic initial susceptibility is 103 in the preferred direction and 1·9 perpendicular to it, in contrast to the relative normal curve values. Practical consequences of the results are discussed. E. P. Wohlfarth

538.221

9381. The interpretation of the magnetic properties of the rare earth ferrites. L. NÉEL. *C.R. Acad. Sci.* [*Paris*] **239,** 8–11 (*July* 5, 1954) *In French.*

Gives a molecular field treatment of the properties of the rare earth ferrites $Fe_2O_3.M_2O_3$ (Forestier *et al.*). It is assumed that the lattice is composed of two sublattices, one being ferrimagnetic (Fe ions) and the other paramagnetic (rare earth ions, M), with weak interaction between them. At very low temperatures the paramagnetic sublattice probably becomes itself ferrimagnetic. E. P. WOHLFARTH

538.221

9382. Thermomagnetic study of gadolinium ferrite. R. PAUTHENET AND P. BLUM. *C.R. Acad. Sci.* [*Paris*] **239,** 33–5 (*July* 5, 1954) *In French.*

Reports magnetization measurements on $Fe_2O_3.Gd_2O_3$ between 4° and 700°K in fields up to 2×10^4 oersted. The magnetization is shown to be given by $\sigma(H,T) = \sigma_0(T) + \chi(T)H$; curves are given showing the variation of σ_0 and $1/\chi$. The magnetization $\sigma_0(T)$ is zero at three temperatures $\theta_1 = 570$°K, $\theta_2 = 678$°K and $\theta_3 = 306$°K. The first two temperatures have been previously observed by Forestier and Guiot-Guillain [Abstr. 8316 (1952)], and the temperature θ_3 is believed to be a "compensation temperature" as discussed by Néel [preceding abstract]. The susceptibility $\chi(T)$ is characterized by two further temperatures $\theta_4 \simeq 9$°K (χ a maximum) and $\theta_5 = -8$°K (paramagnetic Curie point). E. P. WOHLFARTH

538.221

9383. Thermomagnetic study of dysprosium and erbium ferrites. G. GUIOT-GUILLAIN, R. PAUTHENET AND H. FORESTIER. *C.R. Acad. Sci.* [*Paris*] **239,** 155–7 (*July* 12, 1954) *In French.*

Reports magnetization measurements on $Fe_2O_3.M_2O_3$ (M = Dy, Er) between 14° and 700°K in fields up to 2×10^4 oersted. The results are analysed as in the preceding abstract.

E. P. WOHLFARTH

538.221

9384. Ferromagnetic resonance in ferrites. P. A. MILES. Letter in *Nature* [*London*] **174,** 177–8 (*July* 24, 1954).

Reports results for $(1-x)(LiFe_5O_8).x(CdFe_2O_4)$, $Li(Fe_{1-x}Al_x)_5O_8$, $Ni_{1-x}Zn_xFe_2O_4$ at 9470, 23 940 and 34 400 Mc/s. A change of the resonance field was observed if the specimen is placed directly on the resonant cavity end wall. A size effect for the resonance field was observed before the onset of skin effects. The resonance condition used is that proposed by Okamura *et al.* [Abstr. 1747 (1953)], involving an "internal field," H_i. Values of g and H_i are given and shown to depend on x. Resonance measurements at high levels of microwave power give results in agreement with those of Bloembergen and Wang [Abstr. 3651 (1954)]. A tentative discussion is given of the origin of H_i. E. P. WOHLFARTH

538.221

9385. Factors determining the permanent magnet properties of single crystals of Fe_2NiAl. E. A. NESBITT, H. J. WILLIAMS AND R. M. BOZORTH. *J. appl. Phys.*, **25,** 1014–20 (*Aug.*, 1954).

It is shown that fine precipitated particles present in single crystals of Fe_2NiAl are elongated and that the shape anisotropy of these particles is a major factor in determining the coercive force of Fe_2NiAl. For fields of less than 7000 oersteds, ⟨111⟩ directions are the directions of easy magnetization in the (110) plane of the crystal; this is due to the effect of the shape of the precipitated particles, which are oriented in three mutually perpendicular directions. In higher fields, the torque due to this effect decreases and then the [001] direction is the direction of easy magnetization because of intrinsic crystal anisotropy. These conclusions are based on an analysis, and on measurements, of the torque on three mutually perpendicular rods of magnetic material. These rods simulate the precipitated particles in the actual crystal. A.

538.221 : 536.48

9386. Measurements on the coercive force of ticonal down to liquid helium temperatures. D. A. LOCKHORST, A. VAN ITTERBEEK AND G. J. VAN DEN BERG. *Appl. sci. Res. B,* **3,** *No.* 6, 451–5 (1954).

Measurements have been made on the coercive force H_c as a function of temperature of two samples of ticonal and one sample of steel. The H_c versus T curves for the ticonals show the same minimum without saturation down to liquid helium temperatures. The curve for the steel sample, however, shows an increase below liquid nitrogen temperatures and also a saturation in the liquid helium range. A.

538.221 : 538.566 : 621.318.1 : 621.374.3

9387. High-speed magnetic pulsing of ferrites. R. C. LECRAW. Letter in *J. appl. Phys.*, **25,** 678–9 (*May*, 1954).

It has been suggested that when using ferrite attenuators in waveguides as pulsed switches, the switching time has an irreducible min. value, at any rate in the case of NiZn ferrite, due to the recovery time. Experiments were carried out with a rod of MgMn ferrite in a circular waveguide, the exciting current being pulsed by a hydrogen thyratron and monitored by a c.r.t. connected across a 3 Ω series resistor. The length of the exciting current cycle was 0·025 μsec and that of the r.f. pulse, as observed after rectification, the same. The ferrite insertion loss was <1 db and the attenuation in the switch-off state >35 db. H. G. M. SPRATT

538.221 : 538.61

9388. Susceptibility tensor and the Faraday effect in ferrimagnetics. R. K. WANGSNESS. *Phys. Rev.*, **95,** 339–45 (*July* 15, 1954).

The components of the susceptibility tensor have been calculated for the two-sublattice model of a ferrimagnetic in which damping is neglected, and the results related to the theory of the Faraday effect in these materials. It is shown that in most cases the only change necessary is the replacement of the electron gyromagnetic ratio by the effective gyromagnetic ratio of the material. The effect of the sublattice structure is more apparent when the material has a compensation point, for then the rotation can change sign two or more times as a function of temperature or composition. The rotation to be expected for an unmagnetized antiferromagnetic is also determined, and some of the simpler results are generalized to the case in which there are an arbitrary number of sublattices. Other possible sublattice effects are also briefly considered. A.

538.221 : 548.7

Quantum theory of energy anisotropy of ferromagnetic crystals. *See Abstr.* 9744

538.222

9389. On line widths of paramagnetic resonance absorption. H. KUMAGAI, K. ÔNO, I. HAYASHI, H. ABE, J. SHIMADA, H. SHÔNO, H. IBAMOTO AND S. TACHIMORI. *J. Phys. Soc. Japan*, **9**, 369–75 (*May–June*, 1954).

Paramagnetic resonance absorption of microwave (9970 Mc/s) by thirteen salts containing manganese or copper ions was observed with special attention to obtain correct line shapes. The widths obtained were plotted against $1/a^3$, a being the lattice constant when the arrangement of ions are considered as simple cubic lattice. For smaller values of $1/a^3$, line shapes are near to Gaussian type and the widths coincide with those by dipolar coupling calculated by Van Vleck. When $1/a^3$ is larger, that is, when ions come nearer, line shapes are near to resonance types and widths are in general smaller than those expected by dipolar coupling. This narrowing is caused by the existence of exchange coupling between magnetic ions. It is shown that the narrowing in salts of Mn^{++}, Fe^{+++} (S-state) and Cu^{++} can be related to the value of θ in the Curie–Weiss law of static susceptibility $\chi_s \propto C/(T+\theta)$. A.

538.222

9390. Absolute values of absorption coefficients in paramagnetic resonance absorption. H. KUMAGAI, I. HAYASHI, K. ÔNO, H. ABE, J. SHIMADA AND H. SHÔNO. *J. Phys. Soc. Japan*, **9**, 376–7 (*May–June*, 1954).

As a special case of Kramers' equation:

$$\chi'(0) = \frac{2}{\pi}\int_0^\infty \frac{\chi''(H)}{H}dH$$

where $\chi''(H)$ is the absorption coefficient in paramagnetic resonance absorption and $\chi'(0)$ is the static susceptibility. The equation has been checked in cases of paramagnetic resonance in powders of $MnSO_4$, $MnSO_4 . H_2O$, $MnSO_4 . 4H_2O$, $MnSO_4 . 5H_2O$ and single crystals of $CuSO_4 . 5H_2O$. It is found that the relation holds within errors of several per cent. A.

538.222

9391. The magnetic susceptibility of oxygen in a clathrate compound. A. H. COOKE, H. MEYER, W. P. WOLF, D. F. EVANS AND R. E. RICHARDS. *Proc. Roy. Soc. A*, **225**, 112–22 (*Aug.* 6, 1954).

The magnetic susceptibility of oxygen enclosed in a β-quinol clathrate compound has been measured at temperatures from 1 to 20°K. Its behaviour is compared with that calculated for a gas of non-interacting oxygen molecules over the same range of temperature. At high temperatures such a gas would obey Curie's law, but owing to the restriction to odd values of rotational quantum number, the susceptibility of a gas of $O^{16}O^{16}$ molecules would depart from Curie's law at temperatures below 10°K. It is found that at temperatures above 2°K the susceptibility of the oxygen in the clathrate compound agrees within the experimental error with the calculated susceptibility. Below 2°K, however, they do not agree, nor is any difference observed between oxygen of normal isotopic constitution and oxygen enriched to 11% in $O^{18}O^{18}$, whereas the magnetic susceptibility calculated for an enriched specimen of the free gas would differ appreciably from that of the normal gas at temperatures below 2°K. A.

538.222 : 536.63

9392. Paramagnetic and thermal study of the Heusler alloy $MnSnCu_2$. P. TAGLANG AND G. ASCH. *C.R. Acad. Sci.* [*Paris*] **238**, 2500–2 (*June* 28, 1954) *In French.*

Describes susceptibility measurements up to 900°C on a specimen annealed so that its ferromagnetism is destroyed. Two transformations were observed, at 380° and 440°C, and these are also apparent from the results of specific heat measurements. A strong discontinuity in the susceptibility was observed at the melting point, 650°C. E. P. WOHLFARTH

538.222 : 541.132

9393. A study of manganous complexes by paramagnetic resonance absorption. M. COHN AND J. TOWNSEND. Letter in *Nature* [*London*] **173**, 1090–1 (*June* 5, 1954).

The dissociation constants of several unstable manganous complexes in aqueous solution have been measured. G. I. W. LLEWELYN

ELECTROMAGNETISM . ELECTRODYNAMICS 538.3/.5

538.3

9394. The problem of the Maxwell stresses. R. GANS. *Univ. Nac. Tucumán Publ. No.* 641 (*Inst. Fis. Publ. No.* 31) 11–18 (1952) *In Spanish.*

Discusses the expression of the force density in a magnetostatic field, following Cohn's (1900) point of view. L. PINCHERLE

538.3 : 530.12

9395. The singular electromagnetic field. L. MARIOT. *C.R. Acad. Sci.* [*Paris*] **238**, 2055–6 (*May* 24, 1954) *In French.*

The singular field, such that $|\mathbf{E}| = |\mathbf{H}|$ in a suitable frame of reference, is discussed in Riemannian space-time and interpreted in terms of the flux of a photon fluid. R. A. NEWING

538.3 : 530.145

9396. Solution of the Maxwell and Dirac equations for given initial conditions. E. DURAND. *J. Phys. Radium*, **15**, 281–7 (*April*, 1954) *In French.*

Identities analogous to that used in the Kirchhoff problem [Abstr. 3675 (1954)] are set up and used to obtain solutions for general conditions given at time $t = 0$. R. A. NEWING

538.3 : 530.145

The integration of Maxwell's and Lorentz's equations by operational methods. *See Abstr.* 8897

538.3 : 621.3.011

9397. A short modern review of fundamental electromagnetic theory. P. HAMMOND. *Proc. Instn Elect. Engrs I*, **101**, 147–66 (*July*, 1954).

For abstract, see Abstr. 1479 (1954).

538.311 : 53.081.1 : 621.3.013

9398. On the rationalization of the magnetic field. G. DARRIEUS. *Rev. gén. Elect.*, **63**, 263–7 (*May*, 1954) *In French.*

While it is generally admitted that the ratio between the ampere-turn per centimetre and the oersted is $4\pi/10$ the literal application of the transformation rules for the rationalization of units (or rather the rationalization of magnitudes) appears to lead to a contradictory value of 1/10. It is shown how the paradox can be resolved without the necessity of introducing new terms or concepts simply by restoring to the factors 2π and 4π in the unrationalized system their meaning of plane and solid angle. S. C. DUNN (R)

ELECTROMAGNETIC WAVES AND OSCILLATORS 538.56

538.561

9399. An electrodynamic perturbation theorem, with application to nonreciprocal systems. A. G. REDFIELD. *J. appl. Phys.*, **25**, 1021–4 (*Aug.*, 1954).

By means of a slight modification of the macroscopic electrodynamic reciprocity theorem it is possible to obtain the perturbation of the admittance matrix of an electrodynamic device due to a suitable perturbation of the dielectric susceptibility, conductivity and magnetic susceptibility tensors in the device. The theory is applicable to non-reciprocal systems, but in practice can be used to obtain only the first-order perturbation of the admittance matrix. An expression relating the current induced in part of a system due to the motion of current in another part of the system is similarly obtained. D.C. and microwave gyrators are treated, and the connection is pointed out between Faraday rotation in a transmission cavity and the magnetic energy splitting of its circularly polarized normal modes. A.

538.561 : 538.566.2

9400. Dipole resonant modes of an ionized gas column. R. E. B. MAKINSON AND D. M. SLADE. *Austral. J. Phys.*, **7**, 268–78 (*June*, 1954).

It is shown by a quasi-static treatment there is not one but a multiplicity of plasma resonant modes which will emit dipole radiation in a cylindrical column of ionized gas with a radially symmetrical but non-uniform electron density. It is shown that the multiple resonances obtained by Romell [Abstr. 3664 (1951)] in scattering of short waves from a gas discharge column may be qualitatively explained assuming a reasonable electron distribution. Approximate values for the resonant frequencies for a Gaussian distribution, relevant to meteor trails, are found and some of these may be observable. The status of the finite energy loss and phase shift, shown by Herlofson and other authors to arise where the real part of the dielectric constant vanishes, is examined and mechanisms pointed out which modify the expressions given. A.

538.561 : 621.317.761

9401. Heterodyne beat frequency meter. C. S. RANGAN AND Y. L. KHATTAR. *J. sci. industr. Res.*, **13B**, 313–16 (*May*, 1954).

A heterodyne beat frequency meter for the range 100–4000 Mc/s has been constructed. The microwave signal of unknown frequency is beat with an appropriate harmonic from a u.h.f. oscillator (range 100–500 Mc/s), which, in turn, is calibrated against a low frequency crystal calibrator. The accuracy of measurement is ± 5 parts in 10^5. A.

538.566 : 537.533.3 : 621.372.7 : 621.385.833

A combined slow-wave circuit and beam focusing structure. *See Abstr.* 9291

538.566

9402. Theory of spherical diffraction taking leakage [surface] waves into account. K. DEPPERMAN AND W. FRANZ. *Ann. Phys.* [*Leipzig*] **14**, *No.* 6–8, 253–64 (1954) *In German.*

An extension of work previously done on the influence of surface waves in diffraction at a cylinder [Abstr. 8343 (1952)]. Integral equations are used and a semi-asymptotic solution found for the case where the radius/wavelength ratio lies between well-defined limits. The waves are significant for spheres of circumference equal to several hundred wavelengths when they interfere with the geometrically reflected wave and produce fluctuations in field intensity. The most important difference to the cylindrical case is the existence of a phase discontinuity at the transition between the "illuminated" and "dark" sides of the sphere. S. C. DUNN

538.566

9403. The diffraction of electromagnetic waves at a circular cylinder. I. IMAI. *Z. Phys.*, **137**, *No.* 1, 31–48 (1954) *In German.*

A recent paper on this subject by Franz and Deppermann [Abstr. 8343 (1952)] uses a physical approach. The present treatment is purely deductive and employs the calculus of residues and the saddle-point method. It is shown that the residue terms correspond to the "creeping waves" of Franz and Deppermann and the saddle-point term to the geometric-optically reflected wave. It is further established that the term which Franz and Deppermann represent as due to reflection from the "dark" side of the cylinder is virtually non-existent. S. C. DUNN

538.566

9404. On the general formulae of the theory of polarized media. E. DURAND. *C.R. Acad. Sci.* [*Paris*] **238**, 2504–6 (*June* 28, 1954) *In French.*

The known formulae for the field vectors in polarized media are derived from expressions for the Hertzian vectors as retarded potentials of the electric and magnetic polarization vectors. A. T. PRICE

538.566 : 621.396.11

9405. On diffraction by a strip. A. ERDÉLYI AND C. H. PAPAS. *Proc. Nat. Acad. Sci. U.S.A.*, **40**, 128–32 (*Feb.*, 1954).

The variational technique of Levine and Schwinger is used and as a rough approximation, the density of the current induced in the strip is assumed constant. It is shown that even such a crude form of trial function yields fairly good results over the entire spectrum. S. C. DUNN (R)

538.566 : 621.372.8

9406. Modified Luneberg lens. A. S. GUTMAN. *J. appl. Phys.*, **25**, 855–9 (*July*, 1954).

Spherically symmetric optical instruments, and their

desirability for microwaves, are discussed. Application of Hamiltonian optics in analysing the rays in the Luneberg lens has led to formula of a new lens that has spherical symmetry and a focus near its centre. A cylindrical version of this new lens has been designed for operation in the TE_{10} mode. A.

538.566.2/.3 : 551.510.535 : 621.396.11 : 621.396.812.3

9407. Ionosphere and nature of fading patterns of received radio signals. R. N. Singh. *Indian J. Phys.*, **28**, 109–18 (*March*, 1954).

Fading of received radio signals on short wavelengths have been studied in great detail. Fading patterns on various wave-bands for different distances of transmission from Indian as well as foreign transmitting stations have been recorded at different hours and months of the year. The observed fading patterns were analysed using Rayleigh's formula. The amplitude-distribution curves drawn from the fading patterns were compared with the theoretical curves obtained from Rayleigh's probability formula. From these curves, (*a*) variation of the nature of fading at different hours of the day for the same frequency and distance of transmitter, and (*b*) variation of nature of fading of received radio signals at different hours for different distances but for the same frequency of transmission, were studied. The discussion of the former, (*a*), indicates that the nature of fading at least partially depends on the electronic densities which vary with the hour of observation in the ionosphere. Discussion on (*b*) also shows that the nature of fading may depend on the ionospheric conditions at the hour of observation and not the distance of transmission. Thus the nature of fading patterns of received radio signals is at least partially determined by the ionospheric conditions governing the electronic density existing at the time of observations, in the region of the ionosphere from which the reflections of the radio-waves arrive at the receiver. A.

538.566.2

9408. The effect of the oceanic duct on microwave propagation. L. J. Anderson and E. E. Gossard. *Trans Amer. Geophys. Un.*, **34**, 695–700 (*Oct.*, 1953).

A body of experimental radio and meteorological data taken over Cardigan Bay, on the British west coast, is examined to ascertain how radar propagation is affected by the microwave duct lying next to the sea surface. The boundary-layer meteorological profiles are analysed in terms of a semi-empirical relation due to E. L. Deacon, and propagation is predicted according to a method of S. A. Schelkunoff. At 3 cm wavelengths, it is found that the agreement between observation and theory becomes steadily better as wind speed increases, until at speeds above 15 m.p.h. (7 m/s) the consistency is truly striking. At lower wind speeds there is a definite tendency to follow the theoretical pattern, but a great deal of scatter is noted. Possible explanations for this scatter are offered. More scatter is observed at 9 cm than at 3 cm, and the transition to trapping conditions is less definite. The 9 cm waves appear to "feel" the effects of the duct some time before trapping occurs. An interpretation is offered of the fact noted by McPetrie and Starnecki that, in general, high signals are associated with large positive air-sea temperature differences, while low signals are accompanied by large negative differences. Also, Jones' observation that, under unstable conditions, high winds are accompanied by high signals is nicely explained. A.

538.566.2 : 621.396.11

9409. A study of some of the meteorological effects on radio propagation at 96·3 Mc/s between Richmond, Va. and Washington, D.C. D. L. Randall. *Bull. Amer. Meteorol. Soc.*, **35**, 56–9 (*Feb.*, 1954).

An investigation of the relationship of surface meteorological data and corresponding surface refractive indices to radio field strengths in the f.m. frequency band. For meteorological observations during which the wind speeds were $\geqslant 10$ m.p.h., and when fronts, low overcast clouds (< 5000 ft), rain, thunderstorms and fogs were excluded, a 0·70 correlation coefficient was found between hourly surface refractive index and hourly median field strength over a Washington–Richmond path at 96·3 Mc/s. A.

538.566.2 : 621.396.11

9410. Field intensity of scattered wave in radio wave propagation. K. Miya, T. Kobayashi and N. Wakai. *Rep. Ionosphere Res. Japan*, **5**, 55–73 (*June*, 1951).

Scattering coefficients on the earth's surface and the surface of the sea dotted with small islands were calculated as a function only of the angle between the scattered and the normally reflected wave of the point, taking into account the directivities of the transmitting and receiving aerials. It was shown that the time of delay and the waveform of scattered waves calculated by the scattering coefficient agreed well with the observational results. This relation was verified by observational results with short-distance-propagation waves. A.

538.566.2 : 621.396.11 : 621.396.812.3

9411. Studies on mechanism and distribution of short period fading reflected from turbulent ionosphere. F. Minozuma and H. Enomoto. *Rep. Ionosphere Res. Japan*, **7**, 53–9 (*June*, 1953).

Fading phenomena are discussed in terms of the variations of optical paths produced by the turbulent ionosphere. It is pointed out that a simple model of turbulence in the ionosphere conforms to observed data in rate of fading and that physical constants for turbulence are obtained by a field-intensities record. A.

538.566.2 : 621.396.11 : 621.317.74

9412. A rotating interferometer for the measurement of the directions of arrival of short radio waves. H. A. Whale. *Proc. Phys. Soc.* [*London*] *B*, **67**, 553–62 (*July*, 1954).

A method of measuring the bearing angles and the angles of elevation of incoming radio waves is described. In this method two aerials are used, one of which moves in a circular path several wavelengths in diameter. The phases of the radio signals from the two aerials are compared in a system which does not depend on their relative amplitudes and it is shown that this method enables measurements to be made even when there is considerable differential fading between the two aerials. Some experimental records are given yielding the angles of arrival of radio waves. A.

538.566.2 : 551.594.5 : 621.396.11

9413. Radio echoes during aurora. A. G. McNamara and B. W. Currie. *J. geophys. Res.*, **59**, 279–85 (*June*, 1954).

A reassessment of all the Saskatoon data on 56 and 106 Mc/s echoes from aurora suggested that some of the 56 Mc/s echoes might have occurred through backward scatter from the land via the lower part of the ionosphere. These could have originated only through the second-lobe transmission of the radar equipment. Two aerials placed at heights to give the maximum resolution between echoes arising in directions corresponding to the first- and second-lobe signals were used to examine this possibility. The results show that practically all (if not all) the echoes were due to direct reflection from aurora. A.

538.566.2 : 551.594.5 : 621.396.11 : 621.396.9

9414. The location of the auroral absorption zone. V. Agy. *J. geophys. Res.*, **59**, 267–72 (*June*, 1954).

A study of data from a chain of radiowave field-strength recording stations along the 90th meridian suggests that the "auroral absorption zone" coincides with the zone of maximum frequency of occurrence of visible aurora. North of this, there appears to lie a region in which absorption is extremely low. Although the accuracy of location of the absorption zone is limited by use of fixed transmitters and receivers, as well as by the fact that varying modes of propagation are not taken into account, the indications are that it is somewhat farther north and narrower than has been suggested previously. A.

538.566.3

9415. Maxwellian approximation of the general magneto-ionic theory of plasmas subjected to external electric and magnetic fields. R. Jancel and T. Kahan. Letter in *J. Phys. Radium*, **15**, 382–3 (*May*, 1954) *In French.*

It is shown that the Maxwellian distribution of electron velocities is a particular case of the authors' magneto-ionic theory of a feebly ionized gas [Abstr. 5594, 7808 (1953), 1483, 5823, 6745 (1954)].

G. M. BROWN

538.566.3 : 551.510.535

9416. Note on experiments on the ionospheric interaction of radiowaves. M. Boella. Letter in *Nuovo Cimento*, **12**, 140–2 (*July*, 1954) *In Italian.*

Criticizes Cutolo's conclusion [Abstr. 2937 (1954)] that significant auto-interaction by the gyro-interaction mechanism had been demonstrated, on the grounds that the scatter of the results was too great and that simple multipath interference effects may account for the relevant observations. F. F. ROBERTS

538.566.3 : 621.396.11

9417. High multiple radio reflections from the F_2 layer of the ionosphere at Brisbane. K. Baird. *Austral. J. Phys.*, **7**, 165–75 (*March*, 1954).

Continuous night-time records of multiple F_2 reflections at normal incidence have been made at a fixed frequency. The echo patterns have been classified, and qualitative explanations given in terms of humped ionization contours, extending the work of Pierce and Mimno (1940). These patterns have been studied also by a variable gain technique. It is concluded that accurate measurements of reflection coefficients cannot be made by this means. Statistical analyses of occurrences of up to the 10th multiple showed that: (*a*) if no account is taken of presence or absence of E_s, the frequency of occurrence increases towards dawn; (*b*) there is no correlation between the number of reflections observed and the virtual height of the region; (*c*) there is no correlation with "range duplications"; (*d*) inverse correlation between high multiple F reflections and presence of E_s occurs only when the lower region is blanketing; (*e*) there is no correlation between high multiples and the travelling disturbances described by Munro. A study of the presence of very high multiples revealed maxima at the equinoxes. Oblique incidence recording gave no reflections beyond the fifth multiple. A.

MAGNETIC EFFECTS 538.6

538.614

9418. The Faraday effect in gases and vapors. I. L. R. Ingersoll and D. H. Liebenberg. *J. Opt. Soc. Amer.*, **44**, 566–71 (*July*, 1954).

Using a newly developed photoelectric method that will measure magneto-optic rotations as small as 0·0003°, Verdet constants have been measured for helium, neon, hydrogen, deuterium, nitrogen, oxygen, and butane. This has been done at gas pressures less than 3 atm for 22 points over the spectral range 3635 Å to 9875 Å. The average probable error is estimated at slightly less than 1%. Interference filters, calibrated specially for this type of work, have been used to give reasonably monochromatic wavelengths with a resulting uncertainty for most of the spectrum of not more than 10 Å. Where comparison is possible with the work of other observers the agreement is satisfactory. The Faraday dispersion for helium follows closely the inverse-wavelength-squared law. Other gases are roughly similar, except oxygen which is anomalous. The Verdet constants for all gases show a negligible temperature dependence, at constant density, and for all gases except butane show negligible pressure effects for the moderate pressures used. A.

538.614 : 532.77

9419. Anomalous Faraday effect in aqueous solutions of inorganic salts. D. D. Randall and A. M. Taylor. Letter in *J. chem. Phys.*, **22**, 1149–50 (*June*, 1954).

The magneto-optical properties of aqueous solutions of inorganic salts have been investigated in the concentration range 0–0·5 M and the wavelength range 3600–6000 Å. The observed values of the Verdet constant exhibit anomalous behaviour which may be correlated with the ionization energy of the positive ions. G. I. W. LLEWELYN

538.614 : 538.221

9420. Magnetic domains in cobalt by the longitudinal Kerr effect. C. A. Fowler, Jr and E. M. Fryer. Letter in *Phys. Rev.*, **95**, 564–5 (*July* 15, 1954).

Applies the technique previously used for an Fe–Si crystal [Abstr. 5825 (1954)] to a single hexagonal crystal of cobalt. Domain widths observed were about 0·1 mm. E. P. WOHLFARTH

538.632

9421. Shorting and field corrections in Hall measurements. W. F. Flanagan, P. A. Flinn and B. L. Averbach. *Rev. sci. Instrum.*, **25**, 593–5 (*June*, 1954).

A method is given for correcting the measured Hall voltage for shorting by the current contacts and for inhomogeneities in the applied magnetic field. This method is applied to measurements of the Hall coefficient in gold-silver alloys. A.

538.632 : 537.312.5 : 548.7

9422. A.C. Hall and magnetoresistive effects in photoconducting alkali halides. J. R. Macdonald and J. E. Robinson. *Phys. Rev.*, **95**, 44–50 (*July* 1, 1954).

Reports the results of room-temperature measurements of the Hall and magnetoresistive effects for single-crystal potassium bromide containing a low concentration of *F*-centres. Measurements were carried out with strong steady illumination in the *F*-absorption band by means of a new a.c. technique which avoids space-charge polarization effects. The current carriers were found to be negative in sign with a Hall mobility of $12 \cdot 5\ cm^2/volt.sec$ and are undoubtedly electrons photoexcited from *F*-centres. Their maximum concentration was of the order of $10^{10}\ cm^{-3}$. The mobility was found to be substantially independent of light intensity and signal frequency over the limited ranges investigated. Transverse magnetoresistive effects of both positive and negative sign were also observed. Finally, a phenomenological discussion of the experimental results is given. A.

538.652

9423. The approach to saturation of the magnetostriction. L. Néel. Letter in *J. Phys. Radium*, **15**, 376–8 (*May*, 1954) *In French.*

Comments on the theoretical work of Lee [Abstr. 7596 (1954)] on the variation of the magnetostriction of polycrystalline materials in high fields. It is suggested, and verified by comparison with experimental results for nickel and iron, that the terms in Lee's formula involving ρ and ρ^2 ($\rho = K/HI_0$) should be multiplied by a factor close to $0 \cdot 5$ to take account of the effect of the interaction between crystal grains.

E. P. WOHLFARTH

538.652

9424. Contribution to the study of the phenomenon of magnetostriction. R. Vautier. *Ann. Phys.* [*Paris*] **9**, 322–72 (*May–June*, 1954) *In French.*

A theoretical and experimental study of magnetostriction in single crystals of Fe and Ni. A comprehensive treatment of magneto-elastic phenomena in crystalline materials leads to a set of equations for magnetostrictive deformation under various conditions. The effect of specimen shape is treated in detail, and there is some discussion of the phenomenon, observed in large applied fields, of a "forced" magnetostrictive deformation proportional to the field. This component depends upon the direction of observation and, for a given direction of observation, upon the direction of the applied field. It may be of opposite sign to that due to the change of magnetization direction in domains. In Fe, after correcting for this "forced" magnetostriction, the saturation magnetostriction due to the spontaneous magnetization is shown to be -90×10^{-6}. The paper also contains results of magnetostrictive measurements at different temperatures on Co and MnZn ferrites.

A. E. DE BARR

MOLECULAR AND ATOMIC STRUCTURE 539.1

THEORY OF SOLID STATE 539.11

539.11

9425. Critical potentials of soft X-rays and of secondary electrons from copper and their physical significances. II (4). M. Satô. *Sci. Rep. Res. Insts Tôhoku Univ. A*, **5**, 533–53 (*Dec.*, 1953).

In the present investigation the experimental results of several workers on soft X-rays and secondary electrons from copper were closely discussed and the correct values of their critical potentials were determined. These values were reviewed from the author's conception reported previously and were explained as being the dissociation potentials for the dissociation of chained molecules of copper into atoms, without or with accompanying ionization. A.

539.11

9426. The thermal agitation of atoms in crystals. The scattering of X-rays by elastic waves and the elasticity of the crystalline medium. J. Laval. *Bull. Soc. Franç. Minéral. Crist.*, **77**, 219–27 (*Jan.–March*, 1954) *In French.*

A review article. The manner in which X-rays are diffusely scattered from crystals is determined by the spectrum of elastic waves set up by the thermal agitations of the atoms, which in turn are determined by the nature of the forces between the atoms. The latter can therefore be studied by X-ray measurements. The assumption of central forces is inadequate to explain the results obtained so that it is necessary to introduce elastic constants more numerous and with a lower symmetry than those employed by Voigt. These may be grouped in two classes, the one describing static and the other dynamic deformations of the crystal. A. D. LE CLAIRE

539.11

9427. A practical aspect of the study of thermal agitation in crystals: the calculation of the vibration spectrum. H. Curien. *Bull. Soc. Franç. Minéral. Crist.*, **77**, 236–56 (*Jan.–March*, 1954) *In French.*

The frequency ω corresponding to a given wave vector q can be calculated by solving a secular equation relating ω, q and the atomic constants [see Abstr. 8556 (1952)]. A method of solution employing an electronic calculating machine is described and the results are given of a calculation for Na at $T = 40°K$, $80°K$ and $290°K$. The frequency spectrum varies markedly with T and differs considerably from that of Debye. The calculated specific heat agrees excellently with measured values at 40 and $80°K$ but is $\sim 13\%$ too low at $290°K$. This latter discrepancy is discussed but not completely accounted for.

A. D. LE CLAIRE

539.11

9428. Motion of electrons in perturbed periodic lattices. J. Friedel. *J. Phys. Radium*, **15**, 433–8 (*June*, 1954) *In French.*

Reviews critically several treatments of the problem and assesses their range of validity. A method analogous to the W.K.B. approximation is developed and shown to be a good approximation if the perturbing potential is slowly varying in space, the effective electronic mass is close to the actual mass, and the electronic energy is not too close to a turning point in momentum space. E. P. WOHLFARTH

539.11

9429. The frequency of atomic vibrations propagating along the triad axes in sylvine. P. Mériel. *C.R. Acad. Sci.* [*Paris*] **238**, 2303–5 (*June* 14, 1954) *In French.*

The results are given of calculations of the frequency made from measurements of the intensity in various directions of X-rays scattered from sylvine crystals. The values obtained differ from those predicted by Kellermann. A. D. LE CLAIRE

539.11

9430. Interatomic forces in solids. W. Brenig. Note in *Z. Naturforsch.*, **9a**, 560–1 (*June*, 1954) *In German.*

Gives a discussion of methods of calculating the atomic coupling constants which are important in lattice theory. Various degrees of approximation (first, second, third nearest-neighbour interaction) are investigated, with reference to Na. Values of the elastic constants and information about the valency electron wave-functions are used in the calculations. E. P. WOHLFARTH

539.11

9431. Electrons in lattice fields. H. Fröhlich. *Advances in Phys.*, **3**, 325–61 (*July*, 1954).

An extensive account of the theory of the properties of electrons moving in the polarization field of a crystal lattice with which it interacts. The main application is to electrons in ionic crystals, and the theoretical approach is a non-relativistic field theory one. General relations are derived for the Hamiltonian operator describing the motion of the electron in interaction with the lattice field described by a certain complex field vector. Some general properties of this vector are discussed. Approximate wave-functions and eigenvalues of the Hamiltonian are derived, using two methods, viz. a static method equivalent to Hartree's self-consistent field method, and a method taking into account the dynamic properties of the lattice. In the latter approach perturbation theory is used and then shown to be applicable not only if the interaction is weak. The range of validity of the two methods is discussed and it is shown that the results obtained from them do not link up smoothly. Reasons for this failure are given. The problem of the mobility of electrons in ionic crystals is discussed. E. P. WOHLFARTH

539.11

9432. Energy band shapes and band widths in metals. S. Raimes. *Phil. Mag.*, **45**, 727–34 (*July*, 1954).

The density of states curve given by the recent theory of Bohm and Pines is compared with those of the Sommerfeld and Hartree–Fock theories. It is found that the Bohm and Pines curve shows a rudimentary "tail," and the effect of this on the interpretation of the experimental soft X-ray emission data is discussed, with particular reference to the metals sodium, magnesium and aluminium. Although the Bohm and Pines band width is a great improvement on that of the Hartree–Fock theory, it is still much larger than the observed width. It is suggested that this may be partly due to the neglect of the short-range correlation energy: a lower bound to the narrowing of the band from this cause is calculated, and found to be 0·1 eV for sodium. A.

539.11

9433. Note on the applicability of the free-electron network model to metals. C. A. Coulson. *Proc. Phys. Soc.* [*London*] *A*, **67**, 608–14 (*July*, 1954).

The free-electron model of a conjugated molecule is extended to apply to a metal. When each conduction electron is allowed to move freely along the set of one-dimensional lines (i.e. bonds) joining adjacent atoms, a band-structure appears. This is shown to be almost identical with the shape predicted by the conventional tight-binding approximation. The particular example of the π-electrons in a graphite layer is worked out in detail. No empirical parameters are used except the interatomic distance and the crystal structure. A.

539.11

9434. Anisotropy of cyclotron resonance of holes in germanium. R. N. Dexter, H. J. Zeiger and B. Lax. Letter in *Phys. Rev.*, **95**, 557–8 (*July* 15, 1954).

Using infrared excitation of carriers and very low r.f. excitation, anisotropy has been observed in the cyclotron resonance associated with the holes of effective mass $0{\cdot}3\ m_0$. The cyclotron resonance associated with the holes of smaller effective mass was approximately isotropic. The two resonances are interpreted in terms of a model for the top of the valence band in germanium. A. E. DE BARR

539.11

9435. Spin-orbit interaction and the effective masses of holes in germanium. G. Dresselhaus, A. F. Kip and C. Kittel. Letter in *Phys. Rev.*, **95**, 568–9 (*July* 15, 1954).

Two effective masses have been found for holes in Ge. This letter reports that a general second-order perturbation determination of the energy surfaces near $k = 0$ suggests that it is possible to account for the observed features of the hole cyclotron resonances in terms of spin-orbit interaction. A. E. DE BARR

539.11

9436. On the evaluation of certain lattice series. S. K. Roy. *Canad. J. Phys.*, **32**, 509–14 (*Aug.*, 1954).

Lattice series of the Madelung type are at best conditionally convergent; the values of such series, therefore, depend on the method of summation. A criterion is indicated for the choice of a method of summation leading to a physically significant value consistent with the problem in which such a series occurs. Evjen's method of grouping the terms of the series into particular units is discussed in detail for the CsCl type of lattice. It is found that in this case, his method fails to yield directly the unique physically

significant value. An alternative method is proposed which leads at once to the unique value and is applicable to any series of the Madelung type. A.

539.11

9437. On the nature of radiation damage in metals. J. A. BRINKMAN. *J. appl. Phys.*, **25**, 961–70 (*Aug.*, 1954).

The nature of the permanent damage retained in metals from irradiation has been investigated in somewhat greater detail than has been done in the past. The usual assumption has been that the damage in all metals consists chiefiy of interstitial-vacancy pairs. The model presented in this paper reduces to this picture for the light elements but introduces a new concept in the case of damage in the heavy metals, called a displacement spike. Calculations are made from which one can estimate the relationship between the density of interstitial-vacancy pairs and the temperature of the associated thermal spike. An assumption regarding the extent to which interstitial-vacancy pairs persist throughout the duration of the thermal spike has been made, based upon these calculations. The number of interstitial-vacancy pairs predicted in the heavy elements is considerably smaller than that predicted by the former model. A mechanism is proposed by which small dislocation loops can be produced in the heavier metals by irradiation. A.

539.11

9438. The lattice spacings of dilute solid solutions of zirconium, niobium, molybdenum, rhodium, and palladium in ruthenium. A. HELLAWELL AND W. HUME-ROTHERY. *Phil. Mag.*, **45**, 797–806 (*Aug.*, 1954).

Measurements have been made of the lattice spacings of pure ruthenium, and of dilute solid solutions of zirconium, niobium, molybdenum, rhodium, and palladium in ruthenium. In all cases the *c* lattice spacings and axial ratios of the c.p. hexagonal cell are increased by the formation of a solid solution, and at equiatomic percentages of solute the increases are in the order Rh < Pd < Mo < Nb < Zr. The *a* lattice spacings are diminished by Zr and Rh, and increased by Pd, Nb and Mo. With Rh as solute, the increase in *c* and decrease in *a* counterbalance so that the mean volume per atom is unaltered, whereas Zr decreases, and Nb and Mo increase the mean volume per atom. The theoretical significance of these results is discussed. A.

539.11

9439. The van der Waals energy of two helium atoms. K. M. HOWELL. *Proc. Phys. Soc.* [*London*] *A*, **67**, 705–10 (*Aug.*, 1954).

An expression is derived for the van der Waals energy of two helium atoms, exchange terms being neglected. This expression can be expanded as an asymptotic series in inverse powers of the internuclear distance. The first two terms in this series are compared with the dipole–dipole and dipole–quadrupole terms of previous workers. A.

539.11 : 535.32

An experimental confirmation of the Drude free electron theory of the optical properties of metals for silver, gold and copper in the near infrared. *See Abstr.* 9049

MOLECULAR STRUCTURE 539.13

539.13

9440. Rotational energy transfer in diatomic molecules. R. BROUT. *J. chem. Phys.*, **22**, 1189–90 (*July*, 1954).

The rotational energy transition probability upon collision was calculated using approximate results from a previous distorted wave calculation. For heavy homonuclear diatomic molecules, i.e. molecules with molecular weight > 20, the mean transition probability is approximated by $\frac{1}{2}(d_0/r_0)^2$, where d_0 is the internuclear distance and r_0 the kinetic collision diameter. This expression is in agreement with relaxation times as calculated from shock wave data. A.

539.13 : 532.783

9441. Nuclear relaxation and quasi-crystalline structure of liquids. L. GIULOTTO, G. CHIAROTTI AND G. CRISTIANI. Letter in *J. chem. Phys.*, **22**, 1143–4 (*June*, 1954).

Preliminary report on measurements of spin-lattice relaxation times in benzene and other liquids. Values found are somewhat greater than would be predicted by the theory of Purcell *et al.* and it is suggested that this is due to the quasi-bound nature of the rotational motion. R. O. DAVIES

539.13 : 535.376

9442. Inter- and intramolecular energy transfer processes. IV. Hydrogen-hydrocarbon systems. M. M. MOODIE AND C. REID. *J. chem. Phys.*, **22**, 1126–31 (*June*, 1954).

For Pt III, see Abstr. 4406 (1954). Extensive experiments have confirmed the earlier conclusion that long-range energy transfer does not occur between pairs of molecules in solution. Evidence is brought forward to show that the transfer of excitation energy from terphenyl to diphenyl hexatriene under X-ray bombardment in liquid scintillators must be due to a short-range process which occurs after the formation of a molecular complex between diphenyl hexatriene and either a positive terphenyl ion or a very highly excited terphenyl molecule. Results of experiments in heterogeneous systems, in which transfer of excitation energy from adsorbed component to host crystal, and vice versa, sometimes occurs, are summarized. A.

539.132

9443. Evaluation of some electron repulsion integrals needed in molecular quantum mechanics. A method of calculation of two electron multi-center repulsion integrals without the use of the Neumann expansion. R. S. BARKER AND H. EYRING. *J. chem. Phys.*, **22**, 1177–81 (*July*, 1954).

Consideration has been given to two of the electronic repulsion integrals arising in the quantum mechanical energy calculation of the triatomic hydrogen molecular complex when no restrictions are placed on the effective nuclear charges of the composite atomic orbitals. The formulation of the integrals is first developed on a general basis and then restricted to the H_3 molecule. The possibility of extension of the mathematical processes to similar electron inter-

action integrals in more complex molecules is pointed out. The integration formulae are given as rapidly converging series. [See also Abstr. 4790 (1954)] A.

539.132

9444. Use of nuclear attraction integral approximations in molecular quantum mechanics. R. S. BARKER AND H. EYRING. *J. chem. Phys.*, **22**, 1182–8 (*July*, 1954).

Most molecular quantum-mechanical studies of today make use of eigenfunctions composed of atomic orbitals. Such eigenfunctions give rise to difficult multicentre integrals which are usually evaluated by approximate methods. A study of the accuracy of such methods and of their derived results has long been desirable. Certain approximations for three-centre nuclear attraction integrals are here examined. Complete sample calculations are made with the approximate integral values for the triatomic activated complex molecule, H_3. The use of the Mulliken approximate evaluation of integrals in the Heitler–London treatment for H_3 gives a binding energy 7·6 kcal/mole less than does the use of exact integrals. On modifying the Heitler–London treatment by inclusion of screening constants for the outer and central atomic orbitals the Mulliken type approximate integrals gave for a trial calculation a binding energy 5·3 kcal/mole better than the best previous determination. This trial calculation (using the parametric values $R = 1{\cdot}8$, $Z_0 = 1$, $Z_m = 1{\cdot}08$) while the best of several tried is not likely the best that can be found. However, the binding energy of 72·7 kcal/mole calculated is 26 kcal/mole better than the Heitler–London value (53·4 kcal/mole) and 5 kcal/mole better than the Wang-like covalent-bond-plus-ionic-terms determination using a single screening parameter. The cited trial calculation indicates that similar determinations now in progress using exact integral evaluations will give a substantial increase in the calculated binding energy of H_3. This would be, for this simplest polyatomic molecule, the first major advance since 1936. That the approximate calculation is essentially correct is substantiated by the increase in binding energy obtained with the proper screening constant variation for the diatomic molecule. In the H_2 case Wang obtained an improvement from 72·4 kcal/mole to 86·7 kcal/mole over the best covalent-plus-ionic term calculations. A.

539.132

9445. Hyperfine splittings in polyatomic free radicals. S. I. WEISSMAN. *J. chem. Phys.*, **22**, 1378–9 (*Aug.*, 1954).

The hyperfine interaction in polyatomic molecules in doublet states is investigated. It is demonstrated that for molecules undergoing rapid and jittery tumbling the dipolar part of the interaction vanishes. A.

539.132

9446. An experimental value of the force constant of the SH radical. S. LEACH. Letter in *J. chem. Phys.*, **22**, 1261 (*July*, 1954).

A spectroscopic analysis of the near u.v. emission spectra of SH and SD gives $k_e(\mathrm{SH}) = 4{\cdot}192_9 \times 10^5$ dynes/cm, in good agreement with Mitra's prediction [Abstr. 5836 (1954); see also abstract following]. J. HAWGOOD

539.132

9447. Force constants of the hydrides of the second and third periods. S. S. MITRA AND Y. P. VARSHNI. Letter in *J. chem. Phys.*, **22**, 1269–70 (*July*, 1954).

A relation between these [Sheline, Abstr. 8156 (1950)], $\log k_e = A \log Z + \log B$, A and B being constants, is tested against experimental values. It is confirmed well, but with $A = 1{\cdot}9$ for the 2nd period and $A = 4$ for the 3rd period [see also Abstr. 5836 (1954), where $A = 2$ was used for both periods]. For a 3rd period element with n valence electrons, $k_e = (15{\cdot}30 + 1{\cdot}68n)^4$, predicting $k_e(\mathrm{SH}) = 4{\cdot}15 \times 10^5$ dynes/cm (see preceding abstract). J. HAWGOOD

539.132

9448. Correlation between infrared intensities, dissociation energies, and equilibrium internuclear distances for diatomic molecules. H. AROESTE. Letter in *J. chem. Phys.*, **22**, 1273–4 (*July*, 1954).

Values of $(\partial\mu/\partial r)_{r=r_0}$ for NO, CO, HCl and HBr, obtained from infrared intensity measurements, are found to be proportional to E/r_0^2 where E is the dissociation energy and r_0 the equilibrium internuclear distance. G. I. W. LLEWELYN

539.132

9449. Hydrogen bonding in sodium trifluoroacetate–trifluoroacetic acid compounds. W. KLEMPERER AND G. C. PIMENTEL. *J. chem. Phys.*, **22**, 1399–402 (*Aug.*, 1954).

The dissociation pressure of trifluoroacetic acid over two compounds with sodium trifluoroacetate has been measured from 25° to 40°c. One compound is $CF_3COONa \cdot 2CF_3COOH$, and the other is probably $CF_3COONa \cdot CF_3COOH$. The infrared spectra of $CF_3COONa \cdot 2CF_3COOH$, $CF_3COONa \cdot 2CF_3COOD$ and CF_3COONa have been measured in the spectral region 4000 to 650 cm^{-1}. The stability of these salt-acid compounds is attributed to strong hydrogen bonding. The heat of dissociation of $CF_3COONa \cdot 2CF_3COOH$ is +14 kcal per mole of monomeric trifluoroacetic acid, and the OH stretching frequency is found 1150 cm^{-1} below its location in the monomeric acid. A.

539.132 : 535.343.4

Vibration spectra and potential energy constants of ethylene and its deuterosubstitutes. *See Abstr.* 9107

539.132 : 536.66

9450. Heats of combustion and formation of some methony-polysilane and -polysiloxanes: Si–O bond energy. T. TANAKA AND T. WATASE. Letter in *J. chem. Phys.*, **22**, 1268–9 (*July*, 1954).

The following values of $-\Delta H_f^0$ (kcal/mole) were obtained: $Si(OCH_3)_4$, 300; $Si_2O(OCH_3)_6$, 539; $Si_3O_2(OCH_3)_8$, 798; $Si_2(OCH_3)_6$, 445. The Si–O bond energy was found to be about 102 kcal. R. F. BARROW

539.132 : 537.561

The electron spectra of some simple molecules. *See Abstr.* 9338

539.132 : 539.133

9451. Bond-lengths and force constants for methane, silane and germane. R. A. BALLINGER AND N. H. MARCH. Letter in *Nature* [*London*] **174**, 179 (*July* 24, 1954).

The effect of exchange is considered on the energy curves derived for these molecules from Thomas–

Fermi theory of electron distribution. Calculated values of bond-lengths and force constants are by inclusion of the exchange in better agreement with experiment. W. GOOD

539.132 : 541.5

9452. Influence of intramolecular repulsion on bond energies. N. W. LUFT. Letter in *J. chem. Phys.*, **22**, 1260 (*July*, 1954).

The weakening of bonds by radical substitutions cannot be satisfactorily explained by the usual resonance and hyperconjugation approach; an important factor is the effect of the electrostatic or steric repulsions, also responsible for the barriers hindering internal rotation. There is a close correlation in the series of methylated and chlorinated ethanes between the barrier height for internal rotation and differences in bond energies, interpreted as due to changes in interaction energies between non-adjacent bonds. The heat of sublimation of diamond (to C atoms in the ^5S state) can be calculated by this repulsion theory as 176 kcal/mole, using only data from substituted ethanes. J. HAWGOOD

539.132

9453. On the theoretical study of the vibration spectrum of nitrous oxide. M.-L. GRENIER-BESSON AND G. AMAT. *C.R. Acad. Sci.* [*Paris*] **238**, 2067–8 (*May* 24, 1954) *In French.*

The vibration constants of N_2O are calculated and tabulated. For the computation of the interaction coefficient as defined by Nielsen [Abstr. 2885 (1952)] the anharmonic resonance interaction was taken into account. It is remarked that Σ^+ doublets become more widely spaced and Σ^+ triplets become closer as ν_3 increases. This does not entirely agree with Nielsen's formula and results would improve somewhat if the parameter W were considered to depend on the quantum numbers. The calculated frequencies agree well with the experimental values. A. J. TAYLOR

539.132

9454. Molecular vibrations and force constants. M. LARNAUDIE. *J. Phys. Radium*, **15**, 365–74 (*May*, 1954) *In French.*

A survey is given of the matrix theory with a view to the calculation of fundamental frequencies of molecular vibrations. It is shown how force constants can be found. If information on isotopes is available this can be used in a confirmative way. The vibrations of H_2O and D_2O are discussed as examples. A method for obtaining general solutions based on the hypothesis of progressive rigidity of molecules is described. The method is applied to cyclohexane and the results are discussed. The C–C force constants of this molecule have values which are of the same order as those of C–C constants in aliphatic hydrocarbons. They are of the same sign when separated by an even number of C atoms, and of different sign when separated by an odd number. A. J. TAYLOR

539.132

9455. The fundamental vibrations of stibine. I. GAMO. *C.R. Acad. Sci.* [*Paris*] **238**, 2305–7 (*June* 14, 1954) *In French.*

The force constants for SbH_3 and SbD_3 are calculated, using Haynie and Nielsen's normal frequencies [Abstr. 299 (1954)], and a Urey–Bradley potential, including anharmonicity. There is an attraction between H atoms ~ that in AsH_3; in both molecules the interbond angles are near 90°, i.e. p-type bonds. This contrasts with the inter-H repulsion in H_2O, NH_3, with sp_3-type bonds. J. HAWGOOD

539.132

9456. Centrifugal distortion in asymmetric top molecules. III. H_2O, D_2O, and HDO. D. W. POSENER AND M. W. P. STRANDBERG. *Phys. Rev.*, **95**, 374–83 (*July* 15, 1954).

For Pt II, see Abstr. 8101 (1951). Structural and potential constants obtained from infrared data are used with the theory of vibration-rotation interaction to obtain rotational and distortion parameters for the molecules H_2O, D_2O and HDO; transition frequencies calculated using these parameters are compared with those observed in the microwave region, and, in the case of HDO Q-branch lines, a simple relation between the two sets is obtained. The validity of approximation theories as applied to HDO Q-branch transitions is discussed. Methods of analysing the observed spectrum of HDO are described, and so-called "observed" parameters for this molecule are obtained; the rotational constants are found to be $a = 7{\cdot}0396 \pm 0{\cdot}0005 \times 10^5$ Mc/s, $b = 2{\cdot}7360 \pm 0{\cdot}0005 \times 10^5$ Mc/s, $c = 1{\cdot}9186 \pm 0{\cdot}0005 \times 10^5$ Mc/s, $\kappa = -0{\cdot}6841 \pm 0{\cdot}0002$. A.

539.132 : 532.7

9457. Infrared study of the effect of solvent upon ν(NH) in pyrrole. M.-L. JOSIEN AND N. FUSON. *J. chem. Phys.*, **22**, 1169–77 (*July*, 1954).

New data are presented on the NH group stretching frequency of pyrrole in dilute and concentrated solutions in fourteen different solvents and in several solvent mixtures. It is shown that in non-polar solvents ν(NH) of pyrrole obeys the Kirkwood–Bauer relationship, $\delta\nu/\nu = C(D-1)/(2D+1)$, where C is a constant, and D is the solvent dielectric constant. Furthermore, it is shown that C is only slightly affected as ν(HCl) of hydrochloric acid, ν(OD) of methanol-d, or ν(OH) of methanol, ethanol, propanol, or phenol is substituted for the ν(NH) of pyrrole. The deviations from the Kirkwood–Bauer relationship produced by polar solvents and aromatic hydrocarbon solvents are analysed in terms of hydrogen bonding and the formation of molecular complexes. The effect of solvent upon band intensity is also briefly examined. A classification of types of OH and NH solution frequencies is suggested. A.

539.132 : 532.7

9458. A new analysis of the effect of polar solvents upon ν(NH) of pyrrole. M.-L. JOSIEN AND N. FUSON. Letter in *J. chem. Phys.*, **22**, 1264–5 (*July*, 1954).

Previous results (preceding abstract) suggested that in the graph of $(\nu_v - \nu_s)/\nu_v$ against $(D-1)/(2D+1)$, where ν_v, ν_s are pyrrole NH frequencies in vapour and in a solvent of (low-frequency) dielectric constant D, a group of non-polar solvent points lies on the "KB" line, and only chlorinated solvent points to the left of it. Later work on other solutes shows that polar solvent points often appear to the left of the KB line, this region not being characteristic of halogenated solvents only. Using, more correctly, N^2 instead of D, N being the refractive index, the

chlorinated solvent points for pyrrole are shifted to the right of the line. There is thus no clear-cut distinction based only on solvent-induced frequency shifts between solvents forming complexes with pyrrole and those which do not. J. HAWGOOD

539.132 : 539.133

9459. The structure and internal motion of hexachloroethane. D. A. SWICK, I. L. KARLE AND J. KARLE. *J. chem. Phys.*, **22**, 1242–5 (*July*, 1954).

The equilibrium interatomic distances and their average amplitudes of vibration were determined for C_2Cl_6 by means of the microphotometer method in electron diffraction. Internal rotation was investigated, and the interdependence of the effects of the torsional mode and other modes of vibration on the *gauche* Cl–Cl distance is presented graphically. A.

539.132 : 539.133

9460. Electron scattering and internal rotation. J. KARLE. *J. chem. Phys.*, **22**, 1246–50 (*July*, 1954).

Theoretical functions are developed which facilitate the analysis of electron-scattering data from molecules which undergo internal rotation. The probability distributions for distances whose equilibrium positions occur anywhere on the circle of rotation are derived taking into account the combined effect of the overall vibration of the molecular frame and the torsional motion. The extremes of small oscillations and free rotation are treated in detail. A.

539.132 : 541.632

9461. Vibrational energy level splitting and optical isomerism in pyramidal molecules of the type XY_3. R. E. WESTON, JR. *J. Amer. Chem. Soc.*, **76**, 2645–8 (*May* 20, 1954).

The vibrational energy level splittings and rates of racemization have been estimated for several pyramidal molecules with N, P, As, Sb and S as central atoms. The calculations are based on a potential energy function which is derived from known vibrational frequencies and molecular dimensions. It is concluded that energy level splittings for all molecules but ammonia are too small for observation, and that optically active compounds of arsenic, antimony and sulphur should be stable toward racemization at room temperature. A.

539.132 : 548.0 : 535.343.2

Vibration spectrum of crystals of hydrazine dihydrochloride. *See Abstr.* 9088

539.132

9462. A semiempirical treatment of n–π transitions. L. GOODMAN AND H. SHULL. Letter in *J. chem. Phys.*, **22**, 1138–9 (*June*, 1954).

The method of Abstr. 8500 (1954) is applied to n–π transitions in substituted conjugated compounds. Conclusions are drawn about inductive and resonance effects on transition energies, S–T splittings and oscillator strengths, for n–π transitions, using empirical data (α, β, etc.) independently obtained from π–π spectra. J. HAWGOOD

539.132

9463. Polarization of π-electron transitions in aromatic molecules. D. S. MCCLURE. Letter in *J. chem. Phys.*, **22**, 1256–7 (*July*, 1954).

In order to obtain data on the polarization of naphthalene and azulene, which are necessary for the calculation of electronic transitions, some experiments on these compounds as well as on anthracene and phenanthrene were carried out. It was found that the first transition of naphthalene was Ag–B_{3u} (L_b) and the second Ag–B_{2u} (L_b), and that the lowest excited state of azulene was L_b and the next L_a. The lowest excited state of anthracene was found to be L_a and that of phenanthrene L_b. A. J. TAYLOR

539.132

9464. Free electron network model for cyanines and diphenyl polyenes. S. BASU. Letter in *J. chem. Phys.*, **22**, 1270 (*July*, 1954).

Good agreement between calculated and observed absorption frequencies are obtained assuming a free electron network model. No empirical assumptions are necessary. G. I. W. LLEWELYN

539.132

9465. The free-electron theory and the virial theorem. W. LICHTEN. Letter in *J. chem. Phys.*, **22**, 1278–9 (*July*, 1954).

Approximation of electronic wave-functions in molecules by wave-functions for free electrons in a potential well, as originally considered [Abstr. 662 (1954)], does not comply with the virial theorem. The author shows that this deficiency can be avoided without making any essential change in the method of approximation. R. EISENSCHITZ

539.132

9466. A method of determining the electronic transition moment for diatomic molecules. P. A. FRASER. *Canad. J. Phys.*, **32**, 515–21 (*Aug.*, 1954).

A method is described that will give the variation, as a function of internuclear distance, of the electronic transition moment governing intensities in diatomic molecular band systems. Reliable theoretical results and good experimental intensities are used conjointly to find this variation. Once smoothed, the trend may be replaced into the overlap integrals to give relative vibrational transition probabilities better than those given by the approximation "overlap integrals squared," and presumably better than those deduced directly from experiment, since the latter are not smoothed. Limits on the application of the method are suggested; however many band systems fall within these limits. A.

539.132

9467. The box model and electron densities in conjugated systems. J. R. PLATT. *J. chem. Phys.*, **22**, 1448–55 (*Aug.*, 1954).

Pt I describes the π-electron density distributions of some conjugated systems, computed by generalizing Schmidt's model, with the electrons free to move in a properly shaped box of constant potential. Only products and sums of sine functions are needed for rectangular boxes (polyacenes, porphine) and Bessel functions for circular (coronene) or circular-sector boxes (phenanthrene). Plaster models of the π-electron density surface are shown for 10 molecules. In aromatics, ring-shaped regions of high density are found at the same locations as the rings of the carbon skeleton.

In Pt II it is shown that the density maxima in the boxes usually coincide with the high-order bonds of high-density atoms predicted by resonance theory or LCAO theory or the free-electron-network theory,

with similar correspondence for low-density bonds or atoms. This suggests that the common success of these three other theories rests not on their various special assumptions, but on primitive general requirements of wave continuity and orthogonality in space.

In Pt III this point is elaborated into a theorem that the density and transition energy of a closed-shell system are stable under large changes in the one-particle potential function if the changes occur below the highest-filled orbital. Taken together with electron repulsion and antisymmetrization, this helps explain why Coulomb and short-range forces can be successfully approximated by the smoothed-potential model of the nucleus and the free-electron model of metals and molecules.

In Pt IV it is shown that the box model leads to a "periodic table" of stabilities of convex conjugated hydrocarbons. Their possible spectral types are discussed. Some new hydrocarbons are described which may be stable. A.

539.132 : 535.338.4

9468. Spectroscopic constants of molecules. I. On the ground state frequencies of diatoms of the type XX. K. MAJUMDAR AND Y. P. VARSHNI. *Indian J. Phys.*, **28**, 103–8 (*March*, 1954).

The theoretical evaluation of the spectroscopic constants of molecules by quantum mechanics has been retarded due to the difficulties in calculations. In the present and the succeeding papers the authors propose to discuss the existing relations and to suggest new ones—empirical or semi-theoretical—between the spectroscopic constants of molecules. A new unit for "10^5 dynes/cm" viz. "Des." after the pioneer worker Deslandre is proposed. An improved form of Matuyama–Clark relation connecting the ground state frequencies of diatoms (diatomic molecules) formed of the same element is suggested. The relation is $\log \omega_e = g - h \log n^2 V$, where n is the total quantum number of the valence electrons, V the ionization potential and g and h are constants for each group. Values for FrFr, GeGe, SnSn, PoPo and AtAt are predicted. A.

539.132 : 541.124

9469. The activation energy of the $H + H_2$ reaction. V. GRIFFING AND J. T. VANDERSLICE. Letter in *J. chem. Phys.*, **22**, 1142–3 (*June*, 1954).

This is the difference between the energies of the linear H_3 complex and of $H_2 + H$. The values obtained by the same method, MO with configuration interaction, $-43{\cdot}539$ eV for H_3 and $-30{\cdot}317$ eV for H_2, are compared directly, giving the activation energy as $0{\cdot}380$ eV ($8{\cdot}76$ kcal), in good agreement with experimental (5–10 kcal) and spectroscopic ($8{\cdot}50$ kcal) estimates. J. HAWGOOD

539.132

9470. Nuclear quadrupole interaction in bromine and iodine compounds. J. HATTON AND B. V. ROLLIN. *Trans Faraday Soc.*, **50**, 358–64 (*April*, 1954).

A super-regenerative oscillator is used to detect transitions between energy levels produced by interaction of a nuclear electric quadrupole with the field gradient due to bonding electrons for Br^{79} and I^{127} bonded to carbon atoms. The resonance frequency for the transitions is in the neighbourhood of 300 Mc/s. For substituents of methane, the quadrupole coupling increases regularly as hydrogen atoms are replaced by halogens. For halogen substituents of benzene, the quadrupole coupling is correlated with the Hammett's σ of further substituents. The magnitude of the resonance signals from different compounds varies over a wide range and in a number of compounds no resonance has been detected. A.

539.132

9471. Nuclear quadrupole resonances in solid bromine in iodine compounds. A. L. SCHAWLOW. *J. chem. Phys.*, **22**, 1211–14 (*July*, 1954).

Pure quadrupole resonances of bromine or iodine nuclei have been observed in paradibromo- and paradiiodo-benzene; the tetrabromides of carbon, silicon, germanium and tin; germanium and tin tetraiodides; sodium, potassium, and caesium bromates; antimony tribromide and iodide; and cyanogen bromide. For most of these compounds, measurements were made at room temperature and at liquid nitrogen temperature. The results are correlated with chemical bonding and crystal structure data. A.

539.132

9472. The pure quadrupole spectrum of 1, 2, 4-trichlorobenzene. A. MONFILS AND J. DUCHESNE. Letter in *J. chem. Phys.*, **22**, 1275 (*July*, 1954).

In order to test theories developed previously [Abstr. 5849 (1954)] the quadrupole spectrum of this compound was measured. The quadrupole coupling was compared with that of other chlorobenzenes. The values obtained for the coupling constants showed satisfactory agreement with theoretically obtained values. The difference in the constants of dichloro- and trichlorobenzene might indicate that the out-of-plane bending of C–Cl bonds in 1, 2, 4-trichlorobenzene depends on the Cl atom in the 4 position. A. J. TAYLOR

539.132

9473. Effect of the atomic core on the nuclear quadrupole coupling. R. M. STERNHEIMER. *Phys. Rev.*, **95**, 736–50 (*Aug.* 1, 1954).

The effect of the electron core on the nuclear electric quadrupole coupling has been evaluated for several atomic ground states and first excited states. The antishielding produced by the $np \rightarrow p$ and $nd \rightarrow d$ excitations of the core is taken into account in all cases. For the ground states, the effect of the angular modes of excitation predominates, and gives a net shielding of the same order as that predicted by the Thomas–Fermi model, except for two cases of heavy atoms (Cs,W) where the antishielding predominates. For the first excited (p) states of the alkalis (except Li) there is a net antishielding which ranges from 10% for Na to 24% for Cs. Approximate values of the quadrupole correction factor are given for 9 atomic states. A.

539.132 : 535.343–14

9474. Second-order quadrupole effects in asymmetric tops. The microwave spectrum of vinyl iodide. H. W. MORGAN AND J. H. GOLDSTEIN. *J. chem. Phys.*, **22**, 1427–9 (*Aug.*, 1954).

The $J = 3 \rightarrow 4$ transition of the asymmetric rotor, vinyl iodide, has been observed in the region 24 000–26 000 Mc/s. The groupings $3_{12} \rightarrow 4_{13}$ and $3_{13} \rightarrow 4_{14}$ have been studied, and the quadrupolar hyperfine

patterns, arising from the iodine nucleus, have been fitted to second-order theory with an average error of $\pm 0{\cdot}12$ Mc/s. The values determined for the coupling parameters are $\chi_{aa} = -1656$ Mc/s and $\chi_{bb} = +770$ Mc/s, each to within ± 10 Mc/s. On the assumption that the C–I bond is a principal axis of the χ tensor, χ_{zz} the value along the, C–I bond was found to be -1877 Mc/s, and χ_{ab} to equal -765 Mc/s. Assuming planarity, and neglecting centrifugal distortion, the following values of the rotational constants were obtained: $(b + c) = 6325{\cdot}41 \pm 0{\cdot}03$ Mc/s, $(b - c) = 192{\cdot}03 \pm 0{\cdot}05$ Mc/s, and $\kappa = -0{\cdot}9921554 \pm 0{\cdot}0000031$. A.

539.132 : 621.373.43

9475. Field pulses produce nuclear spin echoes. L. Malling. *Electronics*, **27**, 134–7 (*June*, 1954).

The exposure of certain chemicals, particularly lubrication oils, to pulses of 30 Mc/s oscillations superposed on a d.c. polarizing field facilitates the study of their relaxation times. The pulses are fed to coils in which the samples are inserted while pick-up coils connected to a receiver and a c.r.o. enable the delay signals and primary echoes to be examined. To obtain a spin echo, a pair of pulses must be applied to the sample and this is effected by means of a function generator feeding through a nuclear timer and a pulse modulator to the r.f. generator. The function generator is a variable-frequency l.f. oscillator while the nuclear timer consists of 2 or 3 flip-flop multivibrators. The pulse widths required vary from 10 to 100 μsec and the pulse-repetition rates from 0·01 to 100 c/s. An r.f. field of ~ 10 gauss. is generally adequate. H. G. M. Spratt (R)

539.132

9476. Theory of the metallic model including branching. Application to naphthalene. J. Barriol and S. Nikitine. *J. Phys. Radium*, **15**, 426–8 (*May*, 1954) *In French.*

The continuity condition at a branch point of a molecule for the derivatives of the one-dimensional wave-functions of the metallic model are derived from the 3-dimensional Schrödinger equation by an integration over two of the spatial variables. The application to naphthalene shows good agreement in its prediction of energy-levels with the LCAO method, the degeneracies found by ignoring the branch-points in the metallic model being removed. The only empirical parameter used is the internuclear spacing, taken as 1·39 Å. A. J. Taylor

539.132

9477. A modified atomic orbital method with its application to ethylene and oxygen. K. Ohno and T. Itoh. Letter in *J. chem. Phys.*, **22**, 1267 (*July*, 1954).

As A.S.M.O. calculations usually predict too large an energy difference between ionic and covalent states, a new non-empirical method was developed based on different atomic orbitals for covalent and ionic states. Electron pairing for σ-bonds was assumed, atoms were considered in their valence states, but the effects of attached atoms were neglected. Slater-type atomic orbitals were used for numerical calculations on ethylene and oxygen. There is good agreement with experiment. A. J. Taylor

539.132

9478. Electronic structures of the CH radical. J. Higuchi. *J. chem. Phys.*, **22**, 1339–48 (*Aug.*, 1954).

The electronic states and the molecular constants of the ground and lower excited states of the CH radical are calculated by the Heitler–London method and the LCAO-SCF method. In the former, s^2p^2, sp^3 and p^4 configurations of the carbon atom are taken into account for the wave-function, and in the latter LCAO-SCF MOs are calculated for the ground and lower excited states. The interactions between all electrons are considered, but the orthogonal relationship between the 1*s* orbitals of carbon and hydrogen is assumed. As much as possible, the energy integrals were computed from SCF AOs. The results are in general agreement with the observations and Mulliken's prediction. It is concluded that without configuration interaction no satisfactory LCAO-SCF calculation can be made to determine the ground state of the radical as well as of the electronic levels of the carbon atom. A.

539.132

9479. The united atom — separated atom treatment of H_2^+. J. R. Streetman and F. A. Matsen. *J. chem. Phys.*, **22**, 1366–70 (*Aug.*, 1954).

A trial wave-function consisting of a linear combination of 1*S* orbitals centred on the nuclei and on a point half-way between them was used in a variational treatment of H_2^+. A one-electron three-centre integral with non-equal charges which arises in the course of this treatment was evaluated. The effective nuclear charges for minimum energy were found approximately by calculating energies for a range of values of the separated atom charge and of the united atom charge. The lowest energy calculated, $-0{\cdot}5969$ a.u., occurred where both effective nuclear charges are equal at 1·25. The energy value should be compared with $-0{\cdot}6031$ a.u., the exact value, and with $-0{\cdot}6001$ a.u. obtained by hybridizing 1*S* and 2*Pz* orbitals on the separated nuclei. The ratio of the united atom coefficient to separated atom coefficient was found to be 0·3501 for the energy value mentioned. A.

539.132

9480. Molecular orbital theory of orientation in aromatic, heteroaromatic and other conjugated molecules. K. Fukui, T. Yonezawa, C. Nagata and H. Shingu. *J. chem. Phys.*, **22**, 1433–42 (*Aug.*, 1954).

As to the LCAO MO treatment of the orientation problem in chemical reactions of π-electron systems, the frontier electron concept which has been previously introduced by the authors for explaining the reactivities in aromatic hydrocarbons is subjected to an extension in the sense that the frontier orbitals are specified according to the type of reaction. Thus, fundamental postulates relating to the reactivities of π-electron systems are set up, which are believed to include general principles involved in the mechanism of both substitution and addition of electrophilic, nucleophilic, or radical type. On the basis of these postulates it is possible to predict the position of attack in conjugated molecules in all the three types of substitution as well as addition in a consistent manner. There is a nearly perfect agreement between the theoretical conclusions and experimental results hitherto reported. A.

539.132 : 535.343.32

Molecular structure and related problems. Hydrogen bonding effect on the absorption spectra of π-electron systems. *See Abstr.* 9102

539.132 : 537.561

9481. Calculation of ionization potentials. J. L. FRANKLIN. *J. chem. Phys.*, **22,** 1304–11 (*Aug.*, 1954).

Based upon a united atom model, it has been shown that the ionization potentials of complex molecules can be calculated from molecular orbitals formed from group or united atom orbitals. With this method ionization potentials have been calculated for a large number of paraffins, olefins, aromatics, alkyl halides, amines and oxygen compounds. With a few exceptions, the agreement of calculated and measured values is excellent. A.

539.132 : 541.51

9482. The molecular orbital theory of chemical valency. XVI. A theory of paired-electrons in polyatomic molecules. A. C. HURLEY, J. LENNARD-JONES AND J. A. POPLE. *Proc. Roy. Soc. A*, **220,** 446–55 (*Dec.* 22, 1953).

For Pt XV, see Abstr. 7013 (1953). A further step is made in the development of the orbital theory of molecular structure, the object being to allow for the tendency of two electrons in the same space orbital to keep apart because of the repulsive field between them. The description of a molecule is generalized in such a way as to bracket together electrons in pairs, the simple theory of molecular orbitals being used as a starting point for a wider treatment. If two orbitals are used for each electron pair (paired electron orbitals), it is shown that the theory contains as special cases both previous results of the present series of papers and also the valence-bond wave-function, which is shown to be an alternative particular approximation to the general function. A.

539.132 : 541.51

9483. The molecular orbital theory of chemical valency. XVII. Higher approximations. P. P. MANNING. *Proc. Roy. Soc. A*, **225,** 136–46 (*Aug.* 6, 1954).

The equations determining the best electronic wave-functions for a molecule expressed as a linear combination of determinants constructed from a finite number of one-electron orbitals are discussed. It is shown that these orbitals are determined only to within a unitary transformation. As a result the general theory is a natural extension of the single-determinant theory given in the early parts of this series. The group-symmetric properties of the orbitals are discussed. A.

539.133

9484. Rotational magnet moments of $KClFeCl_2$ and $KBrFeBr_2$. P. KUSCH. *J. chem. Phys.*, **22,** 1203–6 (*July*, 1954).

The molecules $KClFeCl_2$ and $KBrFeBr_2$ have rotational magnetic moments much larger than those found in other heavy molecules with large moments of inertia. The maximum magnetic moment of the state of most probable J at a temperature of 935°K is about 72 nuclear magnetons for the first of the molecules and about 50 nuclear magnetons for the second of these molecules. A.

539.133

9485. Deuterium effect on hydrogen bond distances in hafnium dihydride. S. S. SIDHU. *J. chem. Phys.*, **22,** 1062–3 (*June*, 1954).

X-ray diffraction data obtained for carefully-prepared and annealed samples of HfH_2 and HfD_2 show that as deuterium substitutes for hydrogen atoms the hafnium–hydrogen bond distances decrease. The lattice as a whole contracts, and the density increases. Powder diffraction patterns and the structure data for the two compounds are presented. A.

539.133

9486. Equilibrium constant, infrared spectrum, and thermodynamic properties of bromine chloride. H. C. MATTRAW, C. F. PACHUCKI AND N. J. HAWKINS. *J. chem. Phys.*, **22,** 1117–19 (*June*, 1954).

The equilibrium constant of 0·15 for the gaseous system $2BrCl = Br_2 + Cl_2$ has been determined by means of a mass spectrometer. The fundamental vibration frequency of BrCl was observed at 439·5 cm^{-1} wave numbers in the infrared spectrum. The thermodynamic properties $-(F - E_0^0)$, S and Cp were calculated for one mole of gas at atmospheric pressure from 100–1000°K. From the thermodynamic properties, equilibrium constant and known standard state properties of Br_2 and Cl_2, the standard state properties of BrCl were computed. There was no evidence for the existence of $BrCl_3$. A.

539.133

9487. The structure of the nitric oxide dimer. W. J. ORVILLE-THOMAS. Letter in *J. chem. Phys.*, **22,** 1267–8 (*July*, 1954).

A rectangular structure NONO is preferred to a broken linear structure ONNO for the $(NO)_2$ molecule. This is based on X-ray evidence, on the unusually large NO bond length, and on the fact that no vibration corresponding to N–N stretching has been observed. An arrangement for the valency electrons is suggested, so that each oxygen and each nitrogen atom has associated with it one σ-bond, two localized π-bonds and a one-electron σ-type bond.

A. J. TAYLOR

539.133

9488. Directed valency in elements of the first and second short periods. C. E. MELLISH AND J. W. LINNETT. *Trans Faraday Soc.*, **50,** 657–64 (*July*, 1954).

Linnett and Poë, using the procedure of Zimmerman and Van Rysselberghe with hydrogen-like wave-functions, found that the inter-bond angles formed by trivalent nitrogen would be expected to be a little less than the tetrahedral angle. In the present work it has been found, using the atomic wave-functions of Duncanson and Coulson, that the angles would only be expected to be very slightly less than the tetrahedral. The quantitative result, though not the qualitative one, is therefore markedly dependent on the exact form used for the wave-function. Similar calculations to those of Linnett and Poë were carried out for phosphorus to discover whether it was possible, by the method of Zimmerman and Van Rysselberghe, to account for the valency angle in PH_3 being smaller than that in NH_3. It was found that the simple application of that method did not account for this observed difference. An examination of valency

angles in various hydrides and fluorides indicated that these are smaller the greater the electronegativity of the outer atom, or the smaller is the electronegativity of the central atom; and that they are also smaller the greater the number of lone pairs on the central atom. These conclusions are discussed. A.

539.133

9489. Directed valency in certain molecules and complex ions. J. W. LINNETT AND C. E. MELLISH. *Trans Faraday Soc.*, **50**, 665–70 (*July*, 1954).

The method of Zimmerman and Van Rysselberghe, and of Linnett and Poë has been applied to the electronic groups which include one or more electrons in *d*-orbitals and which are presumed to be associated with the ions $Ni(CN)_4^{2-}$, $Fe(CN)_6^{4-}$ and $Mo(CN)_8^{4-}$, and the molecules PF_5 and SF_6. Certain electronic configurations of peak probability have been determined by calculation and it is found that the planar, trigonal bi-pyramidal, octahedral and dodecahedral arrangements of four, five, six and eight valencies in these ions and molecules can be accounted for on the basis of these configurations. A.

539.133 : 535.343–14 : 539.155.2

Microwave spectrum of TeCS and masses of the stable tellurium isotopes. *See Abstr.* 9532

539.133

9490. Proton magnetic resonance spectra of hydrazine salts. I. L. PRATT AND R. E. RICHARDS. *Trans Faraday Soc.*, **49**, 744–51 (*July*, 1953).

Proton magnetic resonance spectra and their second moments are given for crystalline $N_2H_6SO_4$, $N_2H_6(NO_3)_2$, $N_2H_6C_2O_4$, $(N_2H_5)_2SO_4$, $(N_2H_5)_2C_2O_4$ and $N_2H_5BF_4$ at 90°K. The results show that the first two contain the $N_2H_6^{2+}$ ion; the structure of the third is probably $N_2H_5^+ HC_2O_4^-$. The H–H distance in the $N_2H_6^{2+}$ ion, assuming it to be in the symmetrical staggered configurations, is found to be 1·71 Å, with an estimated error of 0·015 Å. If tetrahedral angles are assumed this leads to N–H distances of 1·048 Å. Possible dimensions are also given for the $N_2H_5^+$ ion in the hydrazinium salts. A.

539.133

9491. Proton magnetic resonance spectra of hydrazine salts. II. Line width transitions. C. M. DEELEY, P. LEWIS AND R. E. RICHARDS. *Trans Faraday Soc.*, **50**, 556–60 (*June*, 1954).

Line widths and second moments of the proton magnetic resonance spectra of hydrazine sulphate ($N_2H_6SO_4$) have been measured over the temperature range 90°K to 343°K. A line width transition occurs near 150°K and this has been interpreted in terms of reorientation of the $N_2H_6^{2+}$ ion about the N–N axis, with a potential barrier of about 3 to 4 kcal/mole. Line widths and second moments of $N_2H_6C_2O_4$, $N_2H_6(NO_3)_2$, $N_2H_6F_2$, $N_2H_6Cl_2$, $(N_2H_5)_2C_2O_4$ and $(N_2H_5)_2SO_4$ have also been measured at 90°K and at room temperature. The salts in which strong hydrogen bonding is likely to occur show line width transitions above 90°K, but $N_2H_6Cl_2$ appears to possess a less rigid crystal lattice than the other salts even at 90°K. A.

539.133

9492. The position of the hydrogen atom in a hydrogen bond from nuclear magnetic resonance spectra of hydrazine fluoride. C. M. DEELEY AND R. E. RICHARDS. *Trans Faraday Soc.*, **50**, 560–5 (*June*, 1954).

Proton and fluorine magnetic resonance spectra have been measured for hydrazine fluoride ($N_2H_6F_2$) at 90°K and 20°K respectively. The second moments of the absorption spectra are $47·6 \pm 1·5$ gauss^2 for the hydrogen resonance, and $40·0 \pm 1·3$ gauss^2 for the fluorine resonance. These values have been used to calculate the N–H and H . . . F distances in the crystal. The N–H distance is $1·075 \pm 0·02$ Å compared with 1·03 Å in ammonium chloride, and the difference in the N–H bond lengths is attributed to the very strong N–H . . . F hydrogen bonds in hydrazine fluoride. The F . . . H distance is found to be $1·542 \pm 0·01$ Å, and using the determined N–H bond length, this leads to an N–F distance of $2·62 \pm 0·03$ Å, compared with $2·62 \pm 0·02$ Å determined by X-ray crystallographic methods. A.

539.133

9493. *s*-Triazine. IV. The mass spectrum. C. M. JUDSON, R. J. FRANCEL AND J. A. WEICKSEL. Letter in *J. chem. Phys.*, **22**, 1258–9 (*July*, 1954).

For Pt III, see Abstr. 908 (1954). The main peaks are due to the whole molecule and fragments C_2N_2 and CN of the C_3N_3 ring; there are smaller peaks at C and N but none for C_2N_3 or C_3N_2. Small peaks at 24, 25 are therefore ascribed to C–C due to skeleton rearrangement, with formation of three fragments. Compare benzene, where three C–C fragments are formed, as are C_5 fragments [Abstr. 2537 (1954)].

J. HAWGOOD

539.133 : 535.343–31

9494. Conjugation of several phenyl radicals bonded to a single central atom. H. H. JAFFÉ. *J. chem. Phys.*, **22**, 1430–3 (*Aug.*, 1954).

Spectroscopic evidence is used to show that phenyl radicals are only weakly conjugated with central atoms (S, P, As, Sb, Si, Sn, Pb) not having unshared valence electrons. No resonance interaction is encountered between several phenyl radicals attached to such a central atom, and each phenyl radical makes an independent contribution to the molar extinction coefficients. If the central atom (S, N, P, As, Sb, Bi) has an unshared pair of electrons, extensive conjugation between the phenyl radicals occurs and leads to spectra in sharp contrast to those of simple benzene derivatives. No simple relation exists between the spectra of closely related compounds with different numbers of phenyl radicals attached to the same central atom. The near-ultraviolet absorption spectra of dimethylaniline, methyldiphenylamine, triphenylamine, triphenylarsine, triphenylstibine, triphenylbismuthine, triphenylarsine oxide and triphenylstibine dichloride are reported and compared with those of related compounds of phosphorus, sulphur and group IVA elements. A.

539.133 : 535.375.5

Study of the rise in intensity of Raman lines as a function of the conjugation. *See Abstr.* 9122

539.133 : 535.375.55

Study of the C=O frequency of the Raman spectrum of acetic acid pure and in solutions. *See Abstr.* 9126

539.133

9495. Mean dimensions of rubber-like molecules. T. B. GRIMLEY. Letter in *J. chem. Phys.*, **22**, 1134 (*June*, 1954).

An expression derived by Wall [Abstr. 1542 (1954)] for the mean square end-to-end distance of a chain molecule applies not to a chain molecule but to a chain in which the probability distribution of any element is uniquely defined by that of the preceding element. In a chain molecule it is determined by that of all the other elements in the chain. A formula is given which takes account of this correction. A. J. TAYLOR

ATOMIC STRUCTURE . NUCLEUS . ISOTOPES
539.15

539.152.1

9496. An estimate of the nucleon density in the nucleus from the empirical occupation numbers of the angular momentum eigenvalues. W. THEIS. Note in *Naturwissenschaften*, **41**, *No.* 8, 184 (1954) *In German.*

Different models of the nucleus with range parameter $r_0 = 1{\cdot}4\times10^{-13}$ cm are tested. The best fit is obtained with a nucleus with density constant up to the edge, where it then falls smoothly to zero as a one-sided Gaussian function. G. E. BROWN

539.152.1

9497. Interactions between some two-nucleon configurations. M. G. REDLICH. *Phys. Rev.*, **95**, 448–52 (*July* 15, 1954).

The shell model wave functions may often be mixtures of those for two or more configurations. Calculations based upon a harmonic oscillator central potential with scalar Gaussian interactions between nucleons indicate that there is substantial interaction between various two-nucleon configurations of the $1d_{5/2}$, $2s_{1/2}$, $1d_{3/2}$ shell. The admixtures of the $1f_{7/2}$ subshell, which belongs to the next main level, are, however, small. A mixture of several neighbouring configurations accounts for the *ft* value of $F^{18}(\beta^+)O^{18}$ better than any single configuration. A.

539.152.1

9498. Coulomb energies of light nuclei. D. C. PEASLEE. *Phys. Rev.*, **95**, 717–23 (*Aug.* 1, 1954).

The Coulomb energy differences of light nuclei, determined mostly from β-decay, are fitted to a formula $\Delta E_c = a(Z/A^{\frac{1}{3}}) + b$, where b is an exchange term. With modern data, the nuclear series $A = 4n$, $4n+1, 4n+2, 4n+3$ all yield surprisingly consistent values: $a = 1{\cdot}46$ MeV, $b = -1{\cdot}11$ MeV. The data very clearly exhibit the presence of the exchange term; the value of a corresponds to a square well radius, $R = 1{\cdot}18A^{\frac{1}{3}}\times10^{-13}$ cm. The ΔE_c formula is combined with β-decay energies to determine the spacing $\Delta_{TT'}$ of the lowest-lying states of isotopic spins T, T' for a given A. The observed behaviour of the Δ provides qualitative evidence for dominant supermultiplet structure in light nuclei. A.

539.152.1

9499. On the spin-orbit interaction between nucleons. G. SZAMOSI. *Acta phys. Hungar.* **3**, *No.* 3–4, 243–54 (1954).

The possible energy states of nucleons are investigated on the basis of the well-known Mayer–Haxel–Jensen–Suess theory of nuclear shell structure, assuming a simple Yukawa interaction between the nucleons. The value of the coupling constant is chosen $5e$. The density of the nucleus is assumed to be constant. The proton and neutron levels are given separately, the Coulomb repulsion being also taken into account. The preferred nucleon numbers of the nuclei obtained from the theoretical calculations are in good agreement with the experimental data. The results strongly depend on the choice of g, the parameter of the spin-orbit coupling as well as on the assumptions for the density distribution. A.

539.152.1

9500. Generalized Racah coefficient and its applications. A. ARIMA, H. HORIE AND Y. TANABE. *Progr. theor. Phys.*, **11**, 143–54 (*Feb.*, 1954).

The generalized Racah coefficient, designated as the U-coefficient in this paper, has been defined as the transformation function between two different coupling schemes in pairs of any four angular momenta, corresponding to the Racah coefficient defined as the transformation function between two different coupling schemes of any three angular momenta. Several simple properties of the U-coefficient have been derived, and the method of tensor operators extended to more general problems. Transformation coefficients between LS- and jj-coupling schemes in a many-particle system can be evaluated by making use of these coefficients. A.

539.152.1 : 535.338.333

9501. Spectroscopic isotope shift and nuclear deformations. A. R. BODMER. *Proc. Phys. Soc.* [*London*] *A*, **67**, 622–31 (*July*, 1954).

With a method developed previously [Abstr. 1387 (1954)] the isotope shift due to a difference in nuclear deformation of two isotopes is calculated, making certain simplifying assumptions about the nuclear charge distribution. If both isotopes have a spectroscopic quadrupole moment these may then be used to make an estimate of the deformations. It is found that the difference between the intrinsic and spectroscopic quadrupole moments is quite crucial and that when this is taken into account the anomalously large isotope shift of Eu is satisfactorily explained with the experimentally determined quadrupole moments. Using available data on quadrupole and magnetic moments a tentative examination of other isotope shift data in terms of the deformation-dependent isotope shift indicates that this may perhaps explain the large observed variations. A.

539.152.1 : 539.155.4

9502. Mass differences for isobars capable of double-beta decay. J. T. MCCARTHY. *Phys. Rev.* **95**, 447–8 (*July* 15, 1954).

A list has been prepared of nuclei with $A \leqslant 150$ for which there is a large energy available for double-beta decay. Mass differences were found from experimental data and by calculation with the Wigner formula. In no case is the energy for double-positron emission as large as 1 MeV. About 2 MeV or more is available for the emission of two negative electrons by Ca^{48}, Ge^{76}, Se^{82}, Zr^{96}, Mo^{100}, Cd^{116}, Sn^{124}, Te^{130}, Xe^{136}, and Nd^{150}. Calculations with the mass formula

appear adequate for isobars with $\Delta Z = 2$ when proper attention is paid to magic-number discontinuities. A.

539.152.1

9503. Evidence for subshell at $N = 152$. A. Ghiorso, S. G. Thompson, G. H. Higgins, B. G. Harvey and G. T. Seaborg. Letter in *Phys. Rev.*, **95**, 293–5 (*July* 1, 1954).

A plot of α-particle energy versus mass number for the isotopes of californium indicate a subshell at $N = 152$. A review is given of the evidence for the mass assignments of the nuclides, on which the postulated existence of the subshell depends.

P. T. MATTHEWS

539.152.1

9504. Coulomb energy and nuclear radius. B. G. Jancovici. *Phys. Rev.*, **95**, 389–92 (*July* 15, 1954).

The apparent discrepancy between the values $(1{\cdot}45\times10^{-13}A^{\frac{1}{3}}$ cm) for the nuclear radii derived from mirror nuclei and those $(1{\cdot}2\times10^{-13}A^{\frac{1}{3}}$ cm) derived from μ-mesonic atoms was investigated. The conventional calculation of the Coulomb energy difference ΔE_c between mirror nuclei is improved in two respects: the usual uniform model is replaced by the more elaborate shell model with a finite square well potential, and the exchange terms are taken into account. An equivalent Coulomb radius R_c is defined by $R_c = (6/5)\ (Ze^2/\Delta E_c)$; an equivalent meson radius is defined by $R_M = (5/3)^{\frac{1}{2}}\langle r^2\rangle_{\mathrm{Av}}^{\frac{1}{2}}$, where $\langle r^2\rangle_{\mathrm{Av}}^{\frac{1}{2}}$ is the mean square radius of the electrical charge distribution. The two extreme cases of the pairs (F^{17}, O^{17}) and (O^{15}, N^{15}) are investigated. The computation gives $R_c/R_M = 1{\cdot}18$ in O^{17}, $R_c/R_M = 1{\cdot}07$ in N^{15}. These results are smaller by about 8% than the experimental ratios. However, the experimental discontinuity in R_c at the closure of the p shell is reproduced. A.

539.152.1

9505. Energy levels of light nuclei ($Z = 11$ to $Z = 20$). P. M. Endt and J. C. Kluyver. *Rev. mod. Phys.*, **26**, 95–166 (*Jan.*, 1954).

The presentation follows in detail that of Ajzenberg and Lauritsen (1952) and similar earlier articles and is based mostly on work up to Dec. 1, 1953. No attempt at systematic shell-model assignments.

W. J. SWIATECKI

539.152.1

9506. The nuclear [energy] levels of molybdenum 93. C. Levi and L. Papineau. *C.R. Acad. Sci.* [*Paris*] **238**, 2313–16 (*June* 14, 1954) *In French.*

The β-, γ-, and β–γ, γ–γ coincidence spectra of the 2·7 hr and 45 min activities of Tc^{93} were studied. The 2·7 hr positron spectrum consists of 2 partial allowed spectra ($E_{max} = 820 \pm 10$ and 640 ± 20 keV); assignments are given to the excited states of Mo^{93}, and a level scheme is proposed.

A. O. STANESBY

539.152.1

9507. Statistics of nuclear levels. J. M. B. Lang and K. J. Le Couteur. *Proc. Phys. Soc.* [*London*] *A*, **67**, 586–600 (*July*, 1954).

All the available experimental evidence relating to the statistical distribution of dense nuclear levels is collected together and analysed. The simplest adequate nuclear equation of state is $U = \frac{1}{11}At^2 - t + \frac{1}{8}A^{2/3}t^{7/3}$ MeV which leads to

$$D_0 = 0{\cdot}11A^2(U+t)^{-2}\exp -\left[2\left(\frac{AU}{11}\right)^{1/2} + \frac{3}{32}(11U)^{2/3}\right]\text{MeV}$$

for the spacing of levels of zero angular momentum. The significance of these formulae is discussed. An appendix refines the theoretical level density formula for a Fermi gas with a fixed number of particles; this analysis incidentally yields a slightly more accurate form of the simple Hardy–Ramanujan asymptotic formula for the number of partitions of a positive integer. A.

539.152.1

9508. On nuclear temperature. A. Tomasini. *Nuovo Cimento*, **12**, 134–9 (*July*, 1954) *In Italian.*

Some experiments on nuclear evaporation are discussed and it is shown that by interpreting them with Weisskopf's formula the results agree fairly well. A.

539.152.1 : 537.533.74

Phase shift calculation of high-energy electron scattering. *See Abstr.* 9298

539.152.1 : 537.533.74

High energy electron scattering and nuclear structure determinations. *See Abstr.* 9299

539.152.1 : 537.534.74

Polarization in high energy elastic nucleon-nucleus scattering. *See Abstr.* 9316

539.152.2

9509. On a new method of measuring relaxation times and on the spin of Cr^{53}. K. Halbach. *Helv. phys. Acta*, **27**, *No.* 3, 259–82 (1954) *In German.*

Taking into account the finite magnitude of the modulation frequency, solutions of Bloch's differential equations are derived. They describe the signals observed on the recording instrument of a nuclear induction apparatus, and it is found that, in many cases, significant deviations from the differentiated "slow passage" signals appear. From the present solutions there follows a simple method for the measurement of relaxation times, which is valid even in the presence of field inhomogeneities. This is illustrated by an example. The fundamental equation for the experimental determination of the nuclear spin is likewise modified by the modulation effect. This equation is discussed and applied in the determination of the spin of Cr^{53}. The result is $I(Cr^{55}) = 3/2$. A.

539.152.2

9510. Isotopic spin selection rules. V. Radiations from ^{10}B. G. A. Jones and D. H. Wilkinson. *Phil. Mag.*, **45**, 703–11 (*July*, 1954).

For previous work, see Abstr. 6183 (1953). The excitation function for the reaction Li^6 (α, γ) B^{10} has been investigated with α-particles of up to 1·3 MeV. States in B^{10} are found at $4{\cdot}75 \pm 0{\cdot}02$ MeV and $5{\cdot}162 \pm 0{\cdot}008$ MeV; the known state at 5·11 MeV does not appear ($\omega\gamma < \sim 0{\cdot}02$ eV). This paper confines its attention to the 5·11 and 5·16 MeV states; it is concluded that the former is probably (2—), $T = 0$, and that the latter is (2+), $T = 1$. The

isotopic spin impurity of the ground state of Li^6 and the 5·16 MeV state of B^{10} combined is $\sim 6\times10^{-3}$; that of the 5·11 MeV state is $< 2\times10^{-3}$. The isotopic spin rules are violated in permitting the formation of the 5·16 MeV $T = 1$ state and operate in inhibiting the electric dipole transitions from the 5·11 MeV state. A.

539.152.2

9511. Use of rotating coordinates in magnetic resonance problems. I. I. RABI, N. F. RAMSEY AND J. SCHWINGER. *Rev. mod. Phys.*, **26**, 167–71 (*April*, 1954).

The use of a rotating co-ordinate system to solve magnetic resonance problems is described. On a co-ordinate system rotating with the applied rotating magnetic field the effective field is reduced by the Larmor field appropriate to the rotational frequency. However, on such a co-ordinate system problems can more readily be solved since there is no time variation of the field. The solution in a stationary frame of reference is then obtained by a transformation from the rotating to the stationary frame. This procedure is equally valid in classical and in quantum-mechanical problems. The method is applied both to the molecular beam magnetic resonance method and to resonance absorption and nuclear induction experiments. A.

539.152.2

9512. Nuclear induction in an alternating field. C. MANUS, R. MERCIER, G. J. BÉNÉ, P. M. DENIS AND C. R. EXTERMANN. Letter in *J. Phys. Radium*, **15**, 378 (*May*, 1954) *In French.*

The advantages of nuclear induction experiments with high intensity a.c. and no d.c. fields are detailed [see Abstr. 7656 (1954)]. Small static fields, such as the earth's, shift the pattern and may be measured.

D. H. WHIFFEN

539.152.2

9513. High nuclear polarizations in paramagnetic substances. P. BROVETTO AND S. FERRONI. *Nuovo Cimento*, **12**, 90–8 (*July*, 1954).

The equilibrium of nuclear polarization in paramagnetic substances is studied from the statistical viewpoint. The polarization is higher, the nearer the paramagnetic resonance of the electrons is to saturation. The results obtained do not differ substantially when the electrons behave as a Fermi gas or when the Boltzmann approximation is valid. A.

539.152.2

9514. Quadrupole moment of La^{139}. K. MURAKAWA. *J. Phys. Soc. Japan*, **9**, 391–5 (*May–June*, 1954).

Study of the hyperfine structure of the spectra of La I and La II yielded the result that the quadrupole moment of La^{139} is $(0\cdot9 \pm 0\cdot1)\times10^{-24}$ cm^2. The construction of the light source (liquid-air cooled hollow cathode discharge tube) is described in detail. A.

539.152.2

9515. Magnetic moment of Os^{189}. H. R. LOELIGER AND L. R. SARLES. Letter in *Phys. Rev.*, **95**, 291 (*July* 1, 1954).

Measured by nuclear induction in molten OsO_4. The resonant frequency was compared to that of Cl^{35} in $TiCl_4$, giving a value for the magnetic moment $\mu(Os^{189}) = +0\cdot650655 \pm 0\cdot000081$ n.m. The spin was found to be $I(Os^{189}) = 1\cdot45 \pm 0\cdot13$, thus verifying the value 3/2. J. HUGHES

539.152.2

9516. Nuclear moments. N. F. RAMSEY. *New York: John Wiley and Sons; London: Chapman and Hall*, x + 169 *pp.* Review in *Phil. Mag.*, **45**, 884 (*Aug.*, 1954).

"An introduction to the subject, containing 18 pages of references, tables of nuclear moments, shielding corrections and hyperfine interactions and an appendix on nuclear shell structure."

539.153

9517. Positronium [bound states of the positron-negatron system]. M. DEUTSCH. *Proc. Amer. Acad. Arts Sci.*, **82**, *No.* 7, 331–43 (1953).

539.153

9518. Some electron collision cross sections of CaII. J. T. JEFFERIES. *Austral. J. Phys.*, **7**, 22–4 (*March*, 1954).

The cross-sections for electron collision excitation of the transitions $4S_{1/2} - 4P_{1/2}$ and $4P_{3/2}$ in CaII have been calculated using a distorted wave Born approximation. For electrons of energy 4 eV, the calculated values are respectively $6\cdot6\pi a_0^2$ and $9\cdot9\pi a_0^2$. A.

539.153

9519. Ionization probability curves near threshold for Zn, Cd, and Hg. W. M. HICKAM. *Phys. Rev.*, **95**, 703–5 (*Aug.* 1, 1954).

The ionization probability curves near threshold of the closely related elements zinc, cadmium, and mercury have been obtained using nearly monoenergetic electrons. Structure observed in the curves is interpreted as the result of auto-ionization of states of the atom which arise from the excitation of a single inner shell electron. In the analysis of the results, it is necessary to consider both the optically allowed and forbidden excited states. The energy levels of the optically allowed states of this system have been identified by Beutler, but the locations of the optically forbidden states are unknown. A.

539.153 : 523.11

9520. The origin of atoms. C. MAUGIN. *Bull. Soc. Franç. Minéral Crist.*, **77**, 73–96 (*Jan.–March*, 1954) *In French.*

539.153.4

9521. On the behaviour of the statistically calculated electron density near the nucleus. R. GÁSPÁR. Note in *Acta phys. Hungar.*, **3**, *No.* 3–4, 339–41 (1954) *In German.*

The Thomas–Fermi density has the wrong behaviour at the origin (at the nucleus), going as $r^{-3/2}$ rather than taking on a constant value for small r.

G. E. BROWN

539.153.4

9522. A measure for approximation degree of the approximate TF function for a free neutral atom. K. UMEDA. Note in *J. Phys. Soc. Japan*, **9**, 290–1 (*March–April*, 1954).

The value of a variational integral, which is a minimum for the exact Thomas–Fermi function, is

obtained for various approximations to this function and used as a criterion of goodness of these approximations. G. E. BROWN

539.153.4

9523. On the approximate TF function for compressed neutral atom. K. UMEDA. Note in *J. Phys. Soc. Japan*, **9**, 291–2 (*March–April*, 1954).

Various approximations previously discussed (preceding abstract) to the Thomas–Fermi function are considered for this case. G. E. BROWN

539.153.4

9524. Fermi level, chemical potential, and Gibbs free energy. M. K. BRACHMAN. Letter in *J. chem. Phys.*, **22**, 1152 (*June*, 1954).

Remarks on the relationship between these quantities for the generalized Thomas–Fermi model of an atom. F. ANSBACHER

539.153.4

9525. On an approximation to the Hartree–Fock potential by a universal potential function. R. GÁSPÁR. *Acta phys. Hungar.*, **3**, *No.* 3–4, 263–86 (1954) *In German.*

In addition to a universal potential function discussed in an earlier work [Abstr. 2625 (1953)] to describe the potential resulting from direct interaction in an atom, a simple universal function can be given which reproduces well the charge distribution, namely, $(\rho/Z^2)^{1/3} = Ce^{-\alpha x}/(1 + Ax)$, where ρ is the charge, x is the distance from the nucleus in natural units; α, A and C are suitably chosen constants (the term "universal" means that the quantity is given as a function of Z and is, therefore, applicable to all atoms). Employing this charge density, one can easily correct the universal potential approximately for exchange effects, using a formalism given in 1930 by Dirac. With this corrected potential, eigenfunctions for various states are calculated for Cu and compared with self-consistent field calculations. The agreement is excellent. The Slater exchange correction to the potential [Abstr. 4113 (1951)] is discussed; in this case it amounts to multiplying the Dirac correction by the factor 3/2. The Dirac correction is found to reproduce the electron energy levels in the Cu atom much better than the Slater correction and is therefore preferred. G. E. BROWN

539.153.4

9526. Hartree–Fock–Slater self-consistent field and the calculation of some properties of the Cu^+ ion. J. C. MORROW. *J. phys. Chem.*, **58**, 245–7 (*March*, 1954).

Recent modification of the Hartree–Fock self-consistent field method by J. C. Slater has simplified the problem of obtaining approximate wave-functions corrected for exchange effects. The utility of Slater's approximation is demonstrated by calculation of diamagnetic susceptibility, polarizability and refractivity, Lamb diamagnetic shielding at the nucleus, and structure factors for X-ray and fast electron scattering. The calculations are carried out for the Cu^+ ion, for which Hartree–Fock, Hartree, and Hartree–Fock–Slater wave-functions are available. The results show that the Slater modification is an excellent approximation to the Hartree–Fock method in the calculation of atomic properties; this conclusion is of special moment in investigations of heavy systems for which the Slater method offers great reduction in labour of obtaining wave-functions. A.

539.153.4

9527. Comparison of various approximate exchange potentials. F. HERMAN, J. CALLAWAY AND F. S. ACTON. *Phys. Rev.*, **95**, 371–3 (*July* 15, 1954).

A modification of Slater's simplification of the Hartree–Fock equations is proposed, in which an averaged exchange potential is defined for each set of states having a common angular momentum. For a germanium atom the approximate exchange potentials have been calculated, according to Slater's averaging procedures and according to the authors' own, and compared with the usual Hartree–Fock exchange potentials. A.

539.153.4 : 523.755

9528. The continuous radiative absorption cross section of Fe XIV and the coronal temperature. A. WERNER. *Austral. J. Phys.*, **7**, 25–9 (*March*, 1954).

The continuous radiative absorption cross-section of Fe XIV is calculated, using a Hartree wave-function to evaluate the matrix element for recombination to the ground state. This matrix element was considerably smaller than the value obtained by Hill [Abstr. 5178 (1952)] using the hydrogen-like approximation, but the total cross-section for recombination was not greatly different. Balancing the rates of recombination and collision ionization in the solar corona then gave a temperature of about 2×10^6 °K, compared with Hill's value of 1×10^6 °K. A.

539.153.4 : 541.553

9529. Note on the theory of directed valence. T.-Y. WU. *J. chem. Phys.*, **22**, 1125–6 (*June*, 1954).

The recent observation of Zimmerman and Ryssel-berghe, and Linnett and Pöe that the wave-functions ψ of free atoms, when put in the form of determinants, exhibit the directional property of valence of these atoms, has been examined. It is pointed out that a consistent theory of directed valence cannot be based on these determinantal wave-functions of one single state of the free atom alone. A.

539.154.2

9530. Principal considerations in the periodic system of the elements. VIII. Relationships between atomic nucleus and atomic shell. R. LEPSIUS AND S. K. ASUNMAA. *Naturwissenschaften*, **41**, *No.* 10, 221–7 (1954) *In German.*

For Pts V, VI and VII, see Abstr. 6186 (1953). Presents several graphs and diagrams of $N, Z, (N - A)$ and the s, p, d and f electrons, yielding different relationships between the periods of electron shells and those of nuclear shells [e.g. there exists a relationship between the mechanism of addition of the d-electrons in the Sc–Zn, Y–Cd and Lu–Hg series and the three "magic" ("isotonic") numbers $N20$, $N28$ and $N50$, respectively]. The graphs and diagrams comprise all stable and unstable isotopes known. F. LACHMAN

539.155.2 : 535.321

9531. Precision concentration analysis of D_2O/H_2O by means of phase contrast refractometry. E. Ingelstam, E. Djurle and L. Johansson. *J. Opt. Soc. Amer.*, **44**, 472–7 (*June*, 1954).

By means of a phase contrast refractometer, with a precision in optical path determination of the order of $\lambda/1000$, the refractivity function of the mixture heavy-light water has been determined, and is, for 5461 Å light, at 22·75°c, and within the mole fraction $x < 0{\cdot}04$ so far examined, $-\Delta n(x) \times 10^4 = 47{\cdot}55x + 5{\cdot}8x^2$. It is possible to use this optical method for analysis and control of the contents of D_2O to within about 0·002 mole % at all concentrations. A.

539.155.2 : 535.343–14 : 539.133

9532. Microwave spectrum of TeCS and masses of the stable tellurium isotopes. W. A. Hardy and G. Silvey. *Phys. Rev.*, **95**, 385–8 (*July* 15, 1954).

The microwave spectrum of TeCS has been examined in the rotational transitions $J = 6 \leftarrow 5$, $J = 7 \leftarrow 6$ and $J = 8 \leftarrow 7$. Seven isotopes were observed and from their absorption frequencies mass ratios have been calculated. The mass values are compared with mass spectrographic data and with the recent mass surfaces of Green. The odd-even mass variation is 1·5 milli-mass units for both Te^{123} and Te^{125}. The Te–C bond distance is 1·904 Å and the C–S distance 1·557 Å. The molecular dipole moment was measured as $0{\cdot}172 \pm 0{\cdot}002$ Debye units. A.

539.155.2 : 535.343.4–15

9533. The infrared isotope analyzer. II. J. C. Kluyver and E. W. M. Blokhuis. *Physica*, **20**, 427–32 (*July*, 1954).

For Pt I, see Abstr. 7060 (1953). The investigation of the method for determining isotope ratios by infrared gas analysis has been continued. The amount of carbon dioxide required for a C^{13}/C^{12} analysis has been reduced. The sensitivity is now 0·005 at. % excess C^{13} in 20 mg CO_2 and 0·008 at. % excess C^{13} in 8 mg CO_2. The method has been extended to the determination of the N^{15}/N^{14} ratio in nitrous oxide (*NNO) and the sensitivity reached is 0·015 at. % excess N^{15} in 6 mg N_2O. A.

539.155.2 : 537.591.8

9534. Effects of the cosmic radiation on terrestrial isotope distribution. S. A. Korff. *Trans Amer. Geophys. Un.*, **35**, 103–6 (*Feb.*, 1954).

The effects of the cosmic radiation in building up and altering the terrestrial isotope distribution are computed. The most striking effect is the production of radiocarbon, but as this β-decays to nitrogen it does not alter the distribution permanently. The second important process is the production of tritium, and its subsequent decay into He^3. The problem is discussed quantitatively. Finally it is shown that several other possible reactions do not contribute in an important degree to the existing distribution. A.

539.155.2 : 545.822

Optical spectroscopic determination of hydrogen isotopes in aqueous mixtures. *See Abstr.* 9731

539.155.4 : 548.73

9535. Variety of our sources of information on Avogadro's number and other constants. J. W. M. DuMond and E. R. Cohen. Letter in *Phys. Rev.*, **94**, 1790 (*June* 15, 1954).

The authors refer to thirteen different ways of obtaining Avogadro's number N of which ten are more accurate than the X-ray crystal density method, and of which the most accurate involves the Faraday, magnetic moment of the proton, the Rydberg constant, and the fine-structure splitting in deuterium. Some of the thirteen equations are combined in sets, leaving seven equations in four unknowns. The least-squares method is recommended as being the least arbitrary and most inclusive of all sources of information, and leads to a value $N = (0{\cdot}602472 \pm 0{\cdot}000036) \times 10^{24}$.

A. J. TAYLOR

539.155.4 : 548.73

9536. Remark concerning the absolute value of Avogadro's number. M. E. Straumanis. Letter in *Phys. Rev.*, **95**, 566 (*July* 15, 1954).

See Abstr. 2861 (1954). Comment concerns the value of Avogadro's number proposed by DuMond and Cohen (preceding abstract): in particular the new X-ray wavelength conversion factor implied by it.

A. R. STOKES

RADIOACTIVITY . α-, β- AND γ-RAYS 539.16

539.16.08

9537. The amount of radon in the atmosphere. G. Delibrias. *J. Phys. Radium*, **15**, 78 A–80 A (*May Suppl.*, 1954) *In French.*

An ionization chamber and d.c. amplifier were developed to measure amounts of Rn $\sim 10^{-12}$ curie $litre^{-1}$ (1/10 × tolerance dose). A. O. Stanesby

539.163.1

9538. A calorimetric determination of the half life of Cm^{242}. W. P. Hutchinson and A. G. White. *Atomic Energy Res. Establ.* [*Harwell*] *Rep. C/R* 1365, 7 + v *pp. figs.* (1954).

Calorimetric measurements on a 2 μg sample of Cm^{242} have confirmed the value of 162·5 days previously published for the half-life of this nuclide.

A.

539.163.1

9539. Period of dysprosium-165. E. Rodríguez Mayquez. Note in *An. Real Soc. Espan. Fis. Quím.*, **50**(A), 95–8 (*March–April*, 1954) *In Spanish.*

The decay period of Dy^{165} has such divergent values in the literature that the author has measured this accurately, employing the method suggested by Graves and Walker, which avoids the corrections due to the dead time of the Geiger counter. The final value was $143{\cdot}0 \pm 2{\cdot}6$ min. The period of 1·25 min did not interfere with these measurements. A.

539.163.1

9540. Half-life of curium-242. K. M. Glover and J. Milsted; W. P. Hutchinson and A. G. White. Letters in *Nature* [*London*] **173**, 1238–9 (*June* 26, 1954).

I. Direct counting in a stable, low-geometry proportional counter of α-particles from a practically

weightless source of Cm (purified from Am by ion-exchange methods) was used. Measurements with a statistical accuracy of $\pm 0{\cdot}1\%$ ($>10^6$ counts) were made over a period of ~7 months, giving a half-life of $162{\cdot}4_6 \pm 0{\cdot}27$ days (standard deviation). II. The total heat output of a 2 μg sample of Cm was measured over a period of 12 months in a twin micro-calorimeter with a precision of measurement of $\sim \pm 1{\cdot}5$ μW; the mean value was $163{\cdot}0 \pm 1{\cdot}8$ days (standard deviation). A. O. STANESBY

539.163.1

9541. Preparation and half-life of Cr^{55}. G. A. BAZORGAN, J. W. IRVINE, JR AND C. D. CORYELL. *Phys. Rev.*, **95**, 781 (*Aug.* 1, 1954).

Cr^{55} has been prepared by $Mn^{55}(d, 2p)$ and $Cr^{54}(n, \gamma)$ reactions. A half-life of $3{\cdot}62 \pm 0{\cdot}15$ min is observed and the thermal neutron cross-section for the production of this nuclide is $0{\cdot}36 \pm 0{\cdot}04$ barn. A.

539.163.2

9542. A study of the radioactivity of Pd^{109}. J. MOREAU. Letter in *J. Phys. Radium*, **15**, 380–1 (*May*, 1954) *In French.*

A solenoidal β-spectrometer has been used with a thin source (200 μg/cm^2) to study the β-spectrum ($E_{max} = 1020 \pm 5$ keV) of 13·6 hr Pd^{109}. The β-decay which is simple and shows the allowed form of spectrum is followed by a single $87{\cdot}7 \pm 0{\cdot}2$ keV γ-ray with $\alpha_K/\alpha_{L+M+N} = 0{\cdot}84$. M. A. GRACE

539.163.2

9543. The decay of the 7·68 MeV state in ^{12}C. R. G. UEBERGANG. *Austral. J. Phys.*, **7**, 279–83 (*June*, 1954).

A polonium–beryllium source has been used to investigate the radiations in coincidence with the 4·43 MeV γ-ray leading to the ground state of C^{12}. The coincident radiation consisted of a continuum due to neutrons and a γ-ray of energy 3·05 MeV and intensity 0·12–0·08 that of the 4·43 MeV γ-ray. This indicates that the 7·68 MeV state of C^{12} decays principally by cascade γ-emission. A.

539.163.2

9544. Decay of Sb^{124}. N. H. LAZAR. Letter in *Phys. Rev.*, **95**, 292–3 (*July* 1, 1954).

The γ-radiation following the decay was investigated using a large (3 in. × 3 in.) NaI(Tl) scintillation spectrometer; 2 new γ-rays [0·99 (intensity 0·054) and 1·38 MeV (0·062)] were noted, in addition to those of 0·603 (1·00), 1·71 (0·457) and 2·11 MeV (0·099). A consistent decay scheme is proposed. A. O. STANESBY

539.163.2

9545. The natural radioactivity of lutetium. D. DIXON, A. MCNAIR AND S. C. CURRAN. *Phil. Mag.*, **45**, 683–94 (*July*, 1954).

The radiations from the decay of naturally occurring Lu^{176} are studied in detail. The β^--spectrum, which was found to be of allowed shape, was investigated using internally mounted sources of thickness 0·49 mg/cm^2 and 0·149 mg/cm^2 in a well-shielded proportional tube spectrometer. A half-life of $4{\cdot}56 \pm 0{\cdot}3 \times 10^{10}$ years was obtained for the β-transition with a maximum energy of 425 ± 15 keV and the log *ft* value, 18·75, suggests a 3rd or 4th forbidden transition. Strong electron peaks arising from the internal conversion of an 89 keV γ-ray were observed and a *K*-capture branching ratio of 3 ± 1% is derived from a study of the intensity and nature of the *L* X-rays accompanying the disintegrations. NaI scintillation counters were used for the measurement of γ-rays of energy 310 ± 10 keV and 190 ± 10 keV and the evaluation of their internal conversion coefficients classifies them as E.Q. transitions. The intensities of the γ-quanta and the occurrence of γ–γ coincidences conclusively establish the decay scheme as suggested by Goldhaber and Hill, in which the β^--transition is followed by the γ-rays in cascade. The energies and character of the γ-ray transitions are in close agreement with those predicted from the Bohr–Mottelson rotational model of the nucleus (Bohr and Mottelson, 1953). A.

539.163.2

9546. New isotopes of niobium: Nb^{89} and Nb^{89m}. R. M. DIAMOND. *Phys. Rev.*, **95**, 410–12 (*July* 15, 1954).

A new $1{\cdot}9 \pm 0{\cdot}3$-hour activity was found in niobium fractions isolated from proton-irradiated niobium and zirconium metal foils. By identification of the 78-hour daughter activity, the mass assignment has been made to Nb^{89}. Evidence indicates that the decay is a simple positron emission of $2{\cdot}9 \pm 0{\cdot}4$ MeV maximum energy. Evidence was also obtained for the existence of the $\frac{1}{2}-$ isomeric state in Nb^{89} which decays with a $0{\cdot}8 \pm 0{\cdot}3$-hour half-life by positron emission to the similar 4·4-minute state in Zr^{89}. A.

539.163.2

9547. Disintegration of K^{43}. T. LINDQVIST AND A. C. G. MITCHELL. *Phys. Rev.*, **95**, 444–6 (*July* 15, 1954).

The nuclear spectrum of K^{43} (22·0 hr) has been studied with the help of a magnetic lens spectrograph. K^{43} decays to Ca^{43}, emitting γ-rays having energies 0·369, 0·627, 0·219, 0·393 and 1·00 MeV, the last three being weak. Five β-ray groups were found, of energies 1·839, 1·218, 0·927, 0·460 and 0·243 MeV with relative abundance of 1·6, 5·4, 83·1, 5·4 and 4·5%, respectively. A disintegration scheme is proposed. The K^{43} was prepared by the reaction $A^{40}(\alpha, p)K^{43}$. A.

539.163.2

9548. Spectrometer studies of the radiations of neutron deficient isotopes of cesium and of the *E*3 isomers, Xe^{127m} and Xe^{125m}. H. B. MATHUR AND E. K. HYDE. *Phys. Rev.*, **95**, 708–16 (*Aug.* 1, 1954).

Caesium isotopes produced by $I^{127}(\alpha, xn)$ type reactions in the 60 in. and 184 in. cyclotrons were studied in Geiger counters, a mass spectrometer, β-ray spectrometers, a sodium iodide crystal scintillation spectrometer and a γ–γ coincidence spectrometer. The mass assignment of 30 min Cs^{130} was verified. The 6·25 hr Cs^{127} was shown to decay predominantly by electron capture but also by the emission of positrons of 1·063 MeV and 0·685 MeV energy. Prominent γ-rays of 125 and 406 keV are observed. Cs^{127} exhibits branching decay to 75 sec Xe^{127m} in about one disintegration in 10^4. This isomer was isolated and studied in a scintillation

spectrometer. $E3$ radiation of 175 keV connecting $h_{11/2}$ and $d_{5/2}$ levels is followed by 125 keV $M1$ radiation corresponding to a $d_{5/2}$ — $d_{3/2}$ transition to the ground state. Forty-five minute Cs^{125} is shown to decay predominantly by electron capture and also by the emission of positrons of 2·05 MeV energy. Other lower energy positron groups are present. A prominent γ-ray of 112 keV is observed. In one disintegration in about 10^3, Cs^{125} decays to a 55-sec Xe^{125m}. This isomer emits γ-rays of 75 and 110 keV which are believed to be $E3$ $h_{11/2} - d_{5/2}$ and $M1$ $d_{5/2} - d_{3/2}$ transitions, respectively. An incomplete study of Cs^{123} shows it to be a 6-min positron emitter. A.

539.163.2

9549. Disintegration of Ba^{139}. A. C. G. MITCHELL AND E. HEBB. *Phys. Rev.*, **95**, 727–30 (*Aug.* 1, 1954).

The nuclear radiations from Ba^{139} have been investigated with the help of a magnetic lens spectrograph and scintillation counters in coincidence. β-rays of energy 2·380, 2·227 and 0·822 MeV have been found together with an internal conversion line from a γ-ray of energy 0·163 MeV. The photoelectron spectrum, taken in the lens, showed γ-rays of energies 0·163 and 1·43 MeV. β–γ coincidence experiments, performed with scintillation counters, showed that the 2·23 MeV β-ray group is in coincidence with the 0·163 MeV γ-ray. The 0·163 MeV line has a $K/(L + M)$ ratio of 7·0 and an internal conversion coefficient α_K of 0·22, both of which correspond to an $M1$ transition. The connection with the shell model is discussed. A.

539.163.2 : 541.15

9550. Radiochemical investigation of the spontaneous fission of Cm^{242}. E. P. STEINBERG AND L. E. GLENDENIN. *Phys. Rev.*, **95**, 431–9 (*July* 15, 1954).

Spontaneous fission of Cm^{242} has been investigated by radiochemical determination of the yields of 21 fission products ranging in mass number from 91 to 140. Fission is observed to be asymmetric. The yield-mass-curve exhibits somewhat narrower peaks than observed in induced fission and a peak-to-trough ratio of greater than 700 to 1. Prominent fine structure is observed in the mass distribution, and an analysis of this phenomenon is made. The distribution of nuclear charge in spontaneous fission appears to be essentially the same as that in low-energy induced fission. A.

539.164

9551. On a new theory of alpha-disintegration. K. C. KAR AND S. K. KUNDU. *Indian J. theor. Phys.*, **1**, 87–120 (*Dec.*, 1953).

In the present paper the theory of α-decay previously given by Kar and Choudhury (1950) has been considerably improved and extended and far better agreement obtained with the experimental variation of $\log \lambda$ with energy of emission (E). From the proposed theory the calculated upper limit of E_{max}/E_{min} for nuclei emitting groups of α-particle is 1·50, whereas the experimental value so far obtained is 1·44. This striking confirmation of the theory supports the assumption made regarding the nature of the extra-nuclear, short-range force, namely, that the meson field acting on the outgoing α-particle continuously transforms into fields corresponding to lighter and lighter meson masses till it vanishes at the emission radius (r_1). Accordingly, in the region between the nuclear radius r_0 and r_1 the kinetic energy of the outgoing α-particle is positive. Gamow's theory predicts negative kinetic energy and so imaginary velocity in this region. Owing to this fundamental difference the present theory gives a formula for the disintegration constant involving an important cosine factor in place of the exponential Gamow factor in Gamow's formula. Because the angle is nearly $\pi/2$ the logarithm of the cosine factor has wide variations with energy and the agreement with experiment is found to be decidedly better. The fact that cosine factor, occurring in the wave-function for the α-particle, is nearly zero at the nuclear surface, shows that the nuclear surface is nearly a density node and so a velocity antinode. A.

539.164 : 533.59

9552. The preparation of thin alpha sources by vacuum sublimation. J. MILSTED. *Atomic Energy Res. Establ.* [*Harwell*] *Rep. C/R* 1379, 5 + vii *pp. figs.* (1954).

Describes a convenient apparatus for the preparation of thin α-sources for pulse analysis or α-spectrometry, by the sublimation of the oxides from a tantalum filament at temperatures of about 2000°c, in a high vacuum. It has been used for the preparation of sources containing isotopes of all elements from thorium to curium inclusive, and when operated under these conditions, no fractionation effects have been observed. The sources prepared have given uniformly good resolution. A.

539.164 : 551.594.14 : 778.34

9553. Study of the α-activity in the atmosphere of a laboratory, using nuclear emulsions. E. ERDIK. *J. Phys. Radium.*, **15**, 445–51 (*June*, 1954) *In French.*

Alpha-emitting elements present in the atmosphere of a radioactive laboratory have been identified, and the ratio of the α-activity of the laboratory to that of free air is found to be 1·4. P. ROTHWELL

539.164.74

9554. Stopping power of organic foils for 6 MeV alphas. J. PHELPS, W. F. HUEBNER AND F. HUTCHINSON. *Phys. Rev.*, **95**, 441–4 (*July* 15, 1954).

The stopping power of several thin organic foils has been measured relative to air at 6 MeV. A simple cut-off method provided a direct comparison with air using natural alphas from ThC′. Mean atomic stopping powers relative to air are: Polythene, 0·422; polyvinyl alcohol, 0·515; cellulose acetate, 0·617; regenerated cellulose, 0·597; Mylar, 0·627. Values are also given for the mg per cm^2 of each foil equivalent in stopping power to 1 cm of air. The experimental stopping powers are reproducible to within 2% and average about 3% below values calculated using the additive law and mean excitation potentials for H, C, N and O taken from the literature. A.

539.165

9555. Investigations of β-activities in the heavy water of JEEP carried out in the period of June 1st to August 8th, 1953. T. SIKKELAND. *JENER Rep., No.* 26, 9 *pp.* (*May*, 1954).

With Cu^{++}, Fe^{3+}, Ca^{++}, K^+ and Na^+ as carriers, radio-chemical methods have been used to identify

active isotopes of these elements in the D_2O from the reactor. Their concentrations are also calculated and found to be of the same order of magnitude as found spectrographically. New carriers are pointed out: As, Mn, Co, Ni and La, which may be used in order to proceed further in the investigations. The presence of C^{14} in the D_2O is experimentally indicated. Its concentration experimentally determined is of the same order of magnitude as that which is produced in the reaction $N^{14}(n, p)C^{14}$ during the operation of the reactor. The specific activity of the D_2O in *mC/ml* was measured in the period July 20 to August 8, 1953. In the same period the specific activity was calculated by using the results from the investigations of the active components and the power level of the reactor. The agreement between calculated and measured values is satisfactory. A.

539.165

9556. An experimental study of the electrons of the residual atom ejected from their orbits during the disintegration of P^{32}. G. CHARPAK AND F. SUZOR. Letter in *J. Phys. Radium*, **15**, 378–80 (*May*, 1954) *In French.*

A pair of 2π proportional counters has been used to investigate the spectrum of electrons from a thin source (20 $\mu g/cm^2$) of P^{32} in coincidence with β-rays. Approximate agreement with theory is found for those with energies below 5 keV, but there is an excess (5/1000) for those with greater energies. M. A. GRACE

539.165

9557. Energy determination of Cs^{137} *K* conversion electrons. S. K. BHATTACHERJEE, B. WALDMAN AND W. C. MILLER. *Phys. Rev.*, **95**, 404–6 (*July* 15, 1954).

The electrostatic analyser, previously used to determine the photodisintegration thresholds of deuterium and beryllium, has been used to measure the absolute energy of the *K*-conversion electrons from Cs^{137}. A value of $625{\cdot}2 \pm 0{\cdot}9$ keV was obtained, in agreement with the measurements of others. A.

539.165

9558. Beta decay of F^{20}. C. WONG. *Phys. Rev.*, **95**, 761–4 (*Aug.* 1, 1954).

This was investigated with a magnetic lens spectrometer. The decay proceeds mainly to the first excited state of Ne^{20} by a β-ray of maximum energy $5{\cdot}419 \pm 0{\cdot}013$ MeV, followed by a γ-ray of energy $1{\cdot}627 \pm 0{\cdot}005$ MeV. The excited state transition, with comparative half-life $ft = 9{\cdot}73 \times 10^4$ sec, has the allowed shape down to 1 MeV. A magnetically compensated stilbene scintillation counter has been employed to show that the counts beyond the end point of the intense β-component are due predominantly to scattered electrons and room background. The direct transition to the ground state of Ne^{20} ($Q = 7{\cdot}047 \pm 0{\cdot}014$ MeV) is estimated to have a relative intensity of less than $\sim 3{\cdot}2 \times 10^{-4}$ of the excited state transition, corresponding to a comparative half-life $ft \gtrsim 10^9$ sec. A.

539.165

9559. Beta decay of F^{17} and C^{11}. C. WONG. *Phys. Rev.*, **95**, 765–6 (*Aug.* 1, 1954).

This was investigated with a magnetic lens spectrometer. The positron spectrum of F^{17} consists of one component of maximum energy $1{\cdot}748 \pm 0{\cdot}006$ MeV. The ground-state transition, comparative half-life $ft = 2420$ sec, has the allowed shape down to 570 keV. β-ray branching to the first excited state of O^{17} at 874 keV, if present, has a relative intensity of $<1\%$, corresponding to a comparative half-life $ft \gtrsim 2 \times 10^4$ sec. The positron spectrum of C^{11} consists of one component of maximum energy 968 ± 8 keV. The ground-state transition, comparative half-life $ft = 4170$ sec, has the allowed shape down to 255 keV. A.

539.165 : 531.717

9560. The β-ray absorption spectrum of $^{147}Pm_{61}$ and its application to thickness measurement. L. MANDEL. *Brit. J. appl. Phys.*, **5**, 287–9 (*Aug.*, 1954).

The absorption in aluminium of the β-rays from Pm^{147} was measured and found to be nearly exponential, with an absorption length of $6{\cdot}78$ mg/cm^2 $\pm$ 3%. Curves are given which relate the measuring accuracy with absorber thickness in rapid response β-ray gauges using Pm^{147} and Tl^{204} as sources. These show that, under the same conditions, the use of Pm^{147} leads to greater accuracy at thicknesses below about 20 mg/cm^2, and that, compared with Tl^{204}, this source could usefully extend the lower limit of thickness measurement by a factor of about 4. A.

539.165 : 537.562

9561. Absorption of tritium beta particles in hydrogen and other gases. L. M. DORFMAN. *Phys. Rev.*, **95**, 393–6 (*July* 15, 1954).

The absorption curves for tritium β-particles in hydrogen and helium have been determined by using a spherical ion chamber in which the particular gas serves both as the absorber and the ionization medium. The absorption curves give half-thickness values of $0{\cdot}031$ mg/cm^2 for hydrogen and $0{\cdot}061$ mg/cm^2 for helium. From the saturation currents obtained with a given amount of tritium the relative energy requirement per ion-pair has been measured for hydrogen, helium, oxygen and argon. These values are compared with recent values in the literature. A.

539.165 : 539.163.2

9562. β Spectrum of I^{129} and its decay scheme. E. DER MATEOSIAN AND C. S. WU. *Phys. Rev.*, **95**, 458–61 (*July* 15, 1954).

The decay of I^{129} has been studied with several instruments including a magnetic lens spectrometer, a scintillation spectrometer utilizing a technique in which the activity is introduced into a NaI(Tl) crystal, and a proportional counter. A soft β-radiation whose end point value is measured to be 150 ± 5 keV and a γ-radiation of 38 keV are observed. The shape of the β-spectrum is studied and the *K*-conversion coefficient and the *K/L* conversion ratio for the 38 keV γ-radiation are determined. The β- and γ-radiations are shown to be in coincidence and an upper limit is set for a possible β-branch to the ground state of Xe^{129}. Spin assignments are made which agree with shell model theories of the nucleus and with data available on the decay of the 8-day isomer of Xe^{129}. A.

539.165 : 539.166

9563. β–γ angular correlation of Tm^{170}. J. FUJITA, M. MORITA AND M. YAMADA. *Progr. theor. Phys.*, **11**, 219–23 (*Feb.*, 1954).

β–γ Angular correlation of Tm^{170} is investigated taking into account the Coulomb field. Both the

β–γ angular correlation and β-ray spectrum can be explained by the linear combinations of the first forbidden nuclear matrix elements $\mathfrak{M}(\beta\boldsymbol{r})$, $\mathfrak{M}(\beta\alpha)$ and $\mathfrak{M}(\beta\sigma\times\boldsymbol{r})$ in scalar-, tensor-type interaction of the Fermi theory of β-decay, and it is concluded that the changes of the spin and parity in the successive transitions of $Tm^{170} \rightarrow Yb^{170*} \rightarrow Yb^{170}$ are $1(-) - 2(+) - 0(+)$. A.

539.165 : 550.93

9564. Radiogenic argon measurements. H. A. Shillibeer, R. D. Russell, R. M. Farquhar and E. A. W. Jones. Letter in *Phys. Rev.*, **94**, 1793 (*June* 15, 1954).

Not incorrect dating of the potassium minerals but the fact that NaOH (used as a flux) extracts more of the argon from them than does Na explains an inconsistency obtained in values of the branching ratio, A^{40}/K^{40}. The ratio is now estimated to be 0·090. W. GOOD

539.165.2

9565. Theoretical angular correlations in allowed beta transitions. O. Kofoed-Hansen. *K. Danske Vidensk. Selsk., mat-fys. Medd.*, **28**, *No.* 9, 19 *pp.* (1954).

The angular distribution in β-decay is usually expressed in terms of the β-particle energy and the angle between the directions of emission of the electron and the neutrino. In the present paper, this distribution is transformed into the distribution function for any two of the observable variables, viz. the β-energy, the recoil energy and the angle between the direction of emission of the recoil and the electron. A.

539.165.2

9566. O^{14} decay and the Fermi coupling constant in beta decay. J. B. Gerhart. Letter in *Phys. Rev.*, **95**, 288–9 (*July* 1, 1954).

The O^{14} β^+-spectrum was investigated using a magnetic lens spectrometer: the shape is allowed, with end-point $E_{\beta^+_{max}} = 1835 \pm 8$ keV. The $\frac{1}{2}$-life is $72{\cdot}1 \pm 0{\cdot}4$ sec, giving an *ft* value of 3275 ± 75 sec (the upper limit of branching direct to the ground state of N^{14} is 3×10^{-3}). These results allow the calculation of the Fermi β-decay constant $g_F = 1{\cdot}374 \pm 0{\cdot}016\times10^{-49}$ erg.cm^3, with no other assumption than that of charge independence. Using also the data of neutron decay, $R = 1{\cdot}37^{+0{\cdot}40}_{-0{\cdot}30}$, where $R = g_{GT}^2/g_F^2$ (g_{GT} is the Gamow–Teller β-decay constant). A. O. STANESBY

539.165.2

9567. Tensor forces and the β decay of C^{14} and O^{14}. B. Jancovici and I. Talmi. Letter in *Phys. Rev.*, **95**, 289–91 (*July* 1, 1954).

The long lifetime of C^{14} could be due to an "accidental" cancellation of matrix elements if a strong tensor force is present. This is illustrated using oscillator wave-functions when cancellation can be achieved with interaction parameters which also reproduce the deuteron data and the magnetic and quadrupole moments of N^{14}. This interpretation is supported by the removal of the cancellation (in agreement with experiment) by a Coulomb perturbation in the mirror decay of O^{14}. W. J. SWIATECKI

539.165.2

9568. Radiative capture of orbital electrons. R. J. Glauber and P. C. Martin. Letter in *Phys. Rev.*, **95**, 572–3 (*July* 15, 1954).

The shape of the continuous spectra of γ-rays accompanying orbital electron capture by the nucleus is calculated in the non-relativistic approximation. Coulomb intermediate states are employed. G. E. BROWN

539.166

9569. The directional correlation of the γ rays of A^{38}. J. J. Kraushaar, J. W. Mihelich and A. W. Sunyar. *Phys. Rev.*, **95**, 456–7 (*July* 15, 1954).

The angular correlation of the γ-rays in A^{38} following the β-decay of Cl^{38} has been measured. The correlation function is in agreement with that expected for the spin sequence $3(D)2(Q)0$ or possibly $1(D,Q)2(Q)0$ with a 2·5% quadrupole intensity (out of phase). Gamma-ray lifetime arguments strongly favour the 3–2–0 spin sequence. A.

539.166.08

9570. Inexpensive gamma detector. D. R. Cone and D. W. Garbellano. *Rev. sci. Instrum.*, **25**, 632–5 (*July*, 1954).

A simple and inexpensive radiation detection device has been constructed sensitive to γ-fluxes in the range from a few to a few hundred roentgen per hour. Thus one can distinguish between dangerous and relatively safe radiation levels such as one might expect from radiological warfare, low level atomic blasts, or from "rigged" hydrogen bomb explosions. A typical device consists of two γ-activated crystals in a light-tight container which can be held close to one eye to exclude external light. A radium-activated phosphorescent material is included for light intensity comparison purposes. The more sensitive crystal can be discerned in a γ-radiation of a few r/hr, and its light output matches that of the fluorescent material at levels of 20 to 30 r/hr. The light from the less sensitive crystal matches that of the phosphorescent material at about 100 r/hr. A.

539.166.08

9571. The ferrous sulfate radiation dosimeter: a calorimetric calibration with gamma rays. R. M. Lazo, H. A. Dewhurst and M. Burton. *J. chem. Phys.*, **22**, 1370–5 (*Aug.*, 1954).

The ferrous sulphate radiation dosimeter (herein called the Fricke dosimeter) has been recalibrated by a calorimetric method in which assumptions regarding energy absorbed in the glass and the heat capacity of the calorimeter have been eliminated. The 100 eV yield, $G(Fe^{++} \rightarrow Fe^{+++})$, is $15{\cdot}8 \pm 0{\cdot}3$ for Co^{60} γ-radiation in agreement with the Hochanadel–Ghormley value. The result is compared with other G values reported in the literature and it is recommended that the low value be adopted for Co^{60} γ-radiation and for electrons in the 1–2 MeV range. A.

539.166.2

9572. Radiation-widths of nuclear energy-levels. D. J. Hughes and J. A. Harvey. *Nature* [*London*] **173**, 942–3 (*May* 15, 1954).

A table is given of the radiation widths (Γ_γ) of 33 slow neutron resonances for which reasonably ($\sim \pm 20\%$) accurate measurements are available

(target isotopes $_{45}Rh^{103}$ to $_{92}U^{238}$). The values of Γ_γ show little variation, with a slight decrease as A increases; in particular, Γ_γ is independent of J, the angular momentum of the compound nucleus.

A. O. STANESBY

539.166.2

9573. Gamma radiation from reactions induced by polarized particles. J. M. KENNEDY AND W. T. SHARP. *Phys. Rev.*, **95**, 440 (*July* 15, 1954).

The formulae of Simon which involve γ-radiation have been simplified by carrying out sums over parameters that do not represent observed properties of the radiation. A.

539.166.74

9574. Resonant scattering of gamma-rays in ^{63}Cu and ^{56}Fe. K. ILAKOVAC. *Proc. Phys. Soc.* [*London*] *A*, **67**, 601–7 (*July*, 1954).

The 0·96 MeV γ-radiation following the decay of Zn^{63} is selectively scattered by copper. The intensity of elastic scattering from copper at 90° is several times greater than from iron, provided that the Zn^{63} source is in solution; with a solid source, only slight evidence of resonant scattering has been found. These results are interpreted as resonant nuclear scattering by Cu^{63}, and are analysed in terms of the displacement and broadening of the emission line by nuclear recoil, which persists longer in the liquid than in the solid. The mean life of the 0·96 MeV excited state of Cu^{63} is estimated to be of the order of 6×10^{-13} sec. From the absence of any observable selective scattering by iron of the γ-rays following the decay of Mn^{56}, the mean life of the 0·84 MeV excited state of Fe^{56} is estimated to exceed 8×10^{-12} sec. A.

539.166.74

9575. Nuclear scattering of gamma rays below meson threshold. G. E. PUGH, D. H. FRISCH AND R. GOMEZ. Letter in *Phys. Rev.*, **95**, 590–1 (*July* 15, 1954).

Using an energy-sensitive detector, measurements have been made at 90° and 135° angles and 35–130 MeV γ-ray energies for Be, C, Al, Cu, Sn, Pb and Bi targets. For elements heavier than Al, the results are consistent with classical Thompson scattering from a uniform distribution of protons in a nucleus of radius $(1\cdot1\pm0\cdot2)A^{\frac{1}{3}}\times10^{-13}$ cm. Lighter elements give excess 135° scattering. J. J. WILKINS

539.166.75

9576. Gamma-ray absorption coefficients for NaI, Cu, Ta, and W. P. R. HOWLAND AND W. E. KREGER. *Phys. Rev.*, **95**, 407–10 (*July* 15, 1954).

Gamma-ray absorption coefficients have been measured over a range of energies from 0·279 MeV through 1·113 MeV for NaI, Cu, Ta and W, using an energy-selective scintillation detector. Measurements were made for the absorber position which gave the maximum coefficient, and the results are in good agreement with theory. A.

539.166.835

9577. On the dependence of the relative cross-section for pair production of the atomic number for 6 MeV γ-rays. H. STAUB AND H. WINKLER. *Helv. phys. Acta*, **27**, *No.* 3, 223–34 (1954) *In German.*

Relative nuclear pair production cross-sections have been measured for the γ-rays of the reaction $F^{19}(p\ \gamma)\alpha$, average energy 6·3 MeV, in Al, Cu, Ag, W and Pb, by the technique of coincidence of annihilation quanta. The results show that at this energy the Bethe–Heitler formula, based on Born approximation, and predicting proportionality of the cross-section with Z^2 is very nearly correct. After correcting for shielding effects the cross-section of lead deviates only $-2\pm4\%$ from the Z^2 law, in agreement with the behaviour expected from absorption measurements. A.

539.166.835

9578. High-energy, large-angle distribution of pair electrons produced by bremsstrahlung. R. C. MILLER. *Phys. Rev.*, **95**, 796–8 (*Aug.* 1, 1954).

The results of a calculation of the number of high-energy pair particles emitted into large angles in a pair production process initiated by bremsstrahlung are tabulated. A very approximate estimate of the effect of nuclear screening is given. A.

539.166.835

9579. Gaseous reactions involving positronium. H. S. W. MASSEY AND C. B. O. MOHR. *Proc. Phys. Soc.* [*London*] *A*, **67**, 695–704 (*Aug.*, 1954).

The problems involved in providing a detailed interpretation of the processes involved in the ultimate fate of positrons slowed down in a gas are examined by considering the idealized case of a gas of atomic hydrogen. The processes leading to the formation and dissociation of positronium are considered as well as those which lead to the slowing down of a positronium pair in a gas and to the conversion of ortho- into para-positronium. It is shown that the rate of the latter process probably depends strongly on the kinetic energy of the pair. Elastic collisions of a pair, in its ground state, with gas atoms are determined almost completely by electron exchange interaction, but this is so strong that it cannot be taken account of in a weak coupling treatment. A.

539.166.84

9580. On the form of the inner bremsstrahlung spectrum at low energies, and the ionization accompanying the β-radioactivity of P^{32}. G.-A. RENARD. *C.R. Acad. Sci.* [*Paris*] **238**, 1991–3 (*May* 17, 1954) *In French.*

Extension of earlier measurements [Abstr. 7904 (1953)] to lower energies has shown that the continuous spectrum falls off below ~3 keV. The K X-rays of S^{32} (2·3 keV) appear with the theoretically expected intensity. J. J. WILKINS

539.166.84

9581. On the form of the inner bremsstrahlung spectrum at low energies and the auto-ionization of Sr^{90}–Y^{90} in equilibrium. G.-A. RENARD. *C.R. Acad. Sci.* [*Paris*] **238**, 2072–4 (*May* 24, 1954) *In French.*

See preceding abstract. The continuous spectrum falls off below ~5 keV. K and L X-rays are observed with $\sim1\cdot0$ and $\sim0\cdot1$, respectively, of the theoretical intensities. J. J. WILKINS

539.167

9582. Radiochemistry of the nuclear isomers of Br^{80} in bromoform in the liquid state and in the tetrabromide of carbon in the solid state. P. C. CAPRON AND Y. OSHIMA. *Ann. Soc. Sci. Bruxelles I*, **68**, *No.* 1–2, 72–91 (1954) *In French.*

Results of experiments on retention, which is defined as the fractions of the radioactivity resisting

aqueous extraction, for CBr_4 (solid) and $CHBr_3$ (liquid) irradiated in paraffin at a distance of two centimetres from the source with unfiltered neutrons are:

	$R[Br^{80}$ (18 min)]	$R[Br^{80}$ (4·4 hr)]
CBr_4	0·93 ± 0·02	0·94 ± 0·01
$CHBr_3$	0·55 ± 0·02	0·70 ± 0·04

An interpretation is suggested. In $CHBr_3$ and in an electric field the bromine recoil atoms of the two isomers do not distribute in the same proportion as the capture cross-sections. It seems to indicate that the charges of the recoil atoms are not the same for the two isomers. With $CHBr_3$ the two isomers cannot be separated in an electric field, as has been done with $C_2H_4Br_2$ and C_6H_5Br. The recoil bromine, 4·4 hr, has a very long life in the ion state in $CHBr_3$ solution. A.

539.167.3

9583. The handling and dispensing of chemically processed radioactive isotopes. F. Hudswell, G. A. Neathway, B. R. Payne, J. A. Payne and P. Scargill. *Atomic Energy Res. Establ.* [*Harwell*] *Rep. I/R* 1360, 10 + ix *pp.* + iii *pp. figs.* (1954).

The procedures adopted by the dispensing section at Harwell for preparing shipments for medical and other uses are described. The radioactive isotopes handled include I^{131}, P^{32}, S^{35}, Fe^{55}, Fe^{59}, $Fe^{55}+Fe^{59}$, Na^{22}, Na^{24}, Ca^{45}, Cr^{51} and Au^{198}. Special attention is given to the avoidance of errors at all stages, and to maintaining clean conditions. A.

539.167.3

9584. The preparation for dispensing of miscellaneous radioisotopes. F. Hudswell, B. J. Miles, B. R. Payne, J. A. Payne, P. Scargill and K. J. Taylor. *Atomic Energy Res. Establ.* [*Harwell*] *Rep. I/R* 1386, 10 *pp.* (1954).

The preparation for dispensing of the less commonly handled radioisotopes is described, including Ca^{45}, Cl^{36}, Cr^{51}, Fe^{55}, Fe^{59}, $Fe^{55}+Fe^{59}$, Na^{22}, Na^{24}, S^{35} (carrier-free, and low specific activity solid), Zn^{65}, colloidal radioactive palladium (Pd^{109}), and stable auricyanide complex containing Au^{198}. Improvements in the production of I^{131} and P^{32} are also described. A.

539.169

9585. Industrial applications of radioactivity. J. Guéron. *J. Phys. Radium*, **15**, 65 A–75 A (*May Suppl.*, 1954) *In French.*

A review of work carried out by the French Commissariat à l'Énergie atomique. A. O. Stanesby

NUCLEAR REACTIONS 539.17

539.172 : 537.591.8

Nuclear reactions due to cosmic rays. *See Abstr.* 9369–72

539.172.13

9586. On the electromagnetic excitation of nuclei by charged particles. M. Jean and J. Prentki. *C.R. Acad. Sci.* [*Paris*] **238**, 2290–2 (*June* 14, 1954) *In French.*

The effective cross-section for multipole magnetic excitation is calculated. In the domain of Coulomb excitation, the dipole magnetic term is small relative to electrostatic effects. G. E. Brown

539.172.13

9587. Coulomb excitation of Ta, W, and Au. W. I. Goldburg and R. M. Williamson. *Phys. Rev.*, **95**, 767–71 (*Aug.* 1, 1954).

By using protons as bombarding particles, a study has been made of the yields and angular distributions of Coulomb-excited γ-rays in tantalum (137, 166, 303 keV), tungsten (114 keV) and gold (277, 195, 545 keV). Coincidence experiments show that the 277 keV and the previously unreported 545 keV transition go to the ground state and that the Ta 166 keV line represents a cascade from 303 keV. Thin-target yield data for the 277 keV γ gives an absolute cross-section which is in approximate agreement with the theory while the absolute cross-section for the 545 keV transition is seven times too large. *Note added in proof.*—On correcting an arithmetical error the absolute cross-section for the 545 keV transition is also found to be in approximate agreement with the theory. In both cases the experimental cross-sections increase more rapidly than the theory. Thick-target yields from the five strongest γ-rays are greater than the theory by factors ranging from 6 to 100% between proton energies of 2 and 4 MeV. Agreement with the theory becomes worse with increasing level energy and decreasing proton energy. On the basis of the theory the angular distribution data permit an unambiguous spin assignment of 7/2 to the 545 keV level and give agreement with the previously established spins for the 277 (Au), 137, 303 (Ta) and 114 keV (W) levels. The ratio of $E2$ to $M1$ radiation is $7^{+13}_{-5}/100$ for the 277 keV radiation (Au) and less than 5/100 for the 137 keV radiation (Ta). A.

539.172.13

9588. Diffuse surface optical model for nucleon-nuclei scattering. R. D. Woods and D. S. Saxon. Letter in *Phys. Rev.*, **95**, 577–8 (*July* 15, 1954).

Automatic-computer calculations are reported of the elastic scattering of 20 MeV protons by medium and heavy nuclei, assuming the nuclear interaction to be a spinless, spherically symmetric, complex potential. To fit the experimental results it is found essential to assume a diffuse nuclear surface. The results are not sensitive to the nuclear charge distribution.

P. T. Matthews

539.172.13

9589. Polarization of nucleons elastically scattered from nuclei. R. M. Sternheimer. Letter in *Phys. Rev.*, **95**, 587–9 (*July* 15, 1954).

The observed effect for protons of 200–400 MeV can be explained in terms of a square-well potential and a spin-orbit coupling. It is shown that the changes in sign of the polarization, near the first diffraction minimum, given by previous calculations, can be removed by replacing the sharp nuclear surface by a progressive fall off near the nuclear radius.

P. T. Matthews

539.172.13

9590. Gamma rays from the $Si^{29}(p, \gamma)P^{30}$ reaction. P. M. Endt, J. C. Kluyver and C. van der Leun. Letter in *Phys. Rev.*, **95**, 580 (*July* 15, 1954).

Measurements at the 326 and 414 keV proton

resonances ($5{\cdot}87 \pm 0{\cdot}07$ and $5{\cdot}95 \pm 0{\cdot}07$ MeV levels of P^{30}) are reported. The results fix the first excited state of P^{30} at $0{\cdot}688 \pm 0{\cdot}007$ MeV. Spin, parity and isobaric spin assignments are discussed.

J. J. WILKINS

539.172.13

9591. Activities produced in gold by proton bombardment. C. H. BRADEN, L. D. WYLY AND E. T. PATRONIS, JR. *Phys. Rev.*, **95**, 758–60 (*Aug.* 1, 1954).

12 and 20 MeV protons were used. γ-rays of 1·17, 0·81, 0·58 and 0·255 MeV energy are found in the Hg fraction from the target bombarded at 20 MeV. These γ-rays all decay with a half-life of 42 ± 3 hr and are ascribed to Hg^{195} produced by the $Au(p, 3n)Hg$ reaction. Data concerning the decay of Hg^{197}, Au^{196} and Au^{195} are, in most cases, consistent with previous work. A.

539.172.13 : 539.152.1

9592. The determination of the energy of proton gamma resonances and their use to check theories of nuclear structure. II. S. E. HUNT. *Atomics* [*London*] **5**, 191–4 (*July*, 1954).

For Pt I, see Abstr. 8634 (1954). The distribution of excited energy levels in the nucleus has not yet been completely explained theoretically, partly because of a lack of knowledge of the nature of the internucleonic forces, and partly because of the complexity of the problem. Attempts have been made to simplify the problem by considering the nucleus as analogous to other dynamical systems, and the success and limitations of some of these nuclear models is discussed. A.

539.172.13

9593. Angular distribution of protons produced in the bombardment of carbon-12 by deuterons. II. J. CATALÁ AND F. SENENT. *An. Real Soc. Españ. Fís. Quím.*, **50**, 55–70 (*March–April*, 1954) *In Spanish.*

For Pt I, see Abstr. 2737 (1954). The angular distribution of protons from the $C^{12}(d, p)C^{13}$ reaction is studied in the centre of mass system, corresponding to the higher excited levels of C^{13}. The possible existence of new excited levels of C^{13} is pointed out and for most of them the corresponding spin and parity is given, deduced by comparison of experimental distribution curves with the theoretical ones produced by Marsham following the method of Bhatia, Huang, Huby and News. A.

539.172.13

9594. The angular distributions of α-particles from the $^{14}N(d, \alpha)$ reaction at low bombarding energies. D. CARTWRIGHT, L. L. GREEN AND J. C. WILLMOTT. *Phil. Mag.*, **45**, 742–50 (*July*, 1954).

The angular distribution of the α-particles from the $N^{14}(d, \alpha)$ reaction proceeding to the ground and first excited states of C^{12} have been studied at low bombarding energies. The results show that in the region of 21 MeV excitation energy O^{16} has states 1^-, 2^+, 3^-, but there is no state of zero spin and even parity. A.

539.172.13

9595. The *d*-^{6}Li reactions. F. HIRST, I. JOHNSTONE AND M. J. POOLE. *Phil. Mag.*, **45**, 762–6 (*July*, 1954).

The cross-sections for two of the *d*-Li reactions [namely $Li^6(d, \alpha)He^4$ and $Li^6(d, n)Be^7$] have been measured in the energy range 60 to 450 keV. No evidence has been found for resonances in this region, and the branching ratio between the reactions remains substantially constant over much of the energy range. A.

539.172.13

9596. Yield and angular distribution of protons from $Li^6(d, p)Li^7$. W. E. NICKELL. *Phys. Rev.*, 95, 426–30 (*July* 15, 1954).

The relative yields *v.* energy of protons from the reactions $Li^6(d, p)Li^7$, Li^{7*} have been measured for deuteron energies up to 3·0 MeV. A marked difference in the energy dependence of the yields for the two reactions is noted. The yield for the reaction $Li^6(d, p)Li^7$ shows a broad maximum centred about 1·1 MeV deuteron energy, whereas the yield from the $Li^6(d, p)Li^{7*}$ reaction shows a slow increase throughout the whole energy range covered. Above 2·5 MeV the yield from $Li^6(d, p)Li^{7*}$ exceeds the yield from $Li^6(d, p)Li^7$. The angular distributions of the two proton groups have been observed at 0·825, 2·0 and 3·0 MeV. The angular distributions of the two groups are quite similar at all energies covered. The Butler analysis of the angular distribution data indicates that in both reactions the neutron is captured with one unit of orbital angular momentum. Since Li^6 has even parity and spin 1, this gives odd parity for the ground state and the first excited state of Li^7 and possible values of $\frac{1}{2}$, $\frac{3}{2}$ and $\frac{5}{2}$ for the spins of the ground state and the first excited state. These possible values include the known spin of $\frac{3}{2}$ for the ground state and the currently accepted spin of $\frac{1}{2}$ for the first excited state. A.

539.172.13

9597. Angular correlations in deuteron reactions. A. G. STANLEY. *Phil. Mag.*, **45**, 807–10 (*Aug.*, 1954).

The angular correlations have been measured between the charged particles and γ-rays in the $N^{14}(d, \alpha\gamma)C^{12}$, $N^{14}(d, p\gamma)N^{15}$ and $Be^9(d, p\gamma)Be^{10}$ reactions. In the first two reactions the angular distributions of the charged particles leading to the ground state and first excited state of the final nucleus have also been observed. The results agree with the assignments 2^+ for the first excited levels of C^{12} and Be^{10}, and suggest spins $\frac{1}{2}$ or $\frac{3}{2}$ for the close doublet of N^{15} at 5·3 MeV. A.

539.172.13

9598. Cross sections for the reactions $Ti^{48}(d, 2n)V^{48}$; $Cr^{52}(d, 2n)Mn^{52}$; and $Fe^{56}(d, 2n)Co^{56}$. W. H. BURGUS, G. A. COWAN, J. W. HADLEY, W. HESS, T. SHULL, M. L. STEVENSON AND H. F. YORK. *Phys. Rev.*, **95**, 750–1 (*Aug.* 1, 1954).

Measurements have been made of the $(d, 2n)$ cross-sections of the nuclear species Ti^{48}, Cr^{52} and Fe^{56}. Results are given for incident deuterons in the energy region 1–20 MeV. A.

539.172.13

9599. Angular distributions in the $^{10}B(d, p)^{11}B$ reaction. N. T. S. EVANS AND W. C. PARKINSON. *Proc. Phys. Soc.* [*London*] *A*, **67**, 684–94 (*Aug.*, 1954).

Angular distributions of six proton groups from the reaction $B^{10}(d, p)B^{11}$ were obtained using a scintillation counter spectrometer and an incident

deuteron energy of 7·7 MeV. Distributions for the three longest range groups were also obtained at the additional deuteron energies of 6·2, 7·1 and 8·0 MeV. The results are largely compatible with the normal theory of deuteron stripping, and the five longest range proton groups appear to correspond to in-going p-neutrons. The properties of the first excited state in B^{11} are, however, in some doubt. Possible spin assignments for the lower levels of B^{11} arising from excitation within the p-shell are considered and the corresponding relative values of the neutron capture probability are listed. A.

539.172.3

9600. Study of photodisintegrations using photographic emulsions. III. (γ, p) reaction on copper. R. Chastel. *J. Phys. Radium*, **15**, 459–69 (*June*, 1954) *In French.*

For Pt II, see Abstr. 7739 (1954). Photoprotons produced by irradiation of copper by 17·6 MeV γ-rays have been detected with nuclear emulsions, indicating a cross-section of $(6 \pm 3) \times 10^{-26}$ cm^2. Calculations of the $Cu^{63,65}(\gamma, d)$ cross-section are presented. J. J. WILKINS

539.172.3

9601. Study of the use of γ-rays from the (n, γ) reaction produced by neutrons from a pile. V. O. Eriksen and C. P. Zaleski. Letter in *J. Phys. Radium*, **15**, 492 (*June*, 1954) *In French.*

Neutron-capture γ-rays from Fe, Ti, S and Cu have been used to measure the $Be^9(\gamma, n)$ cross-section in the region 5·4–7·7 MeV. The accuracy achieved so far is $\sim \pm 20\%$. J. J. WILKINS

539.172.3

9602. Photodisintegration thresholds of deuterium and beryllium. J. C. Noyes, J. E. Van Hoomissen, W. C. Miller and B. Waldman. *Phys. Rev.*, **95**, 396–403 (*July* 15, 1954).

The photodisintegration thresholds of deuterium and beryllium have been determined by using the bremsstrahlung produced by monoergic electrons. The absolute energy of the electrons was measured with a cylindrical electrostatic analyser. The binding energy of deuterium was found to be $2{\cdot}227 \pm 0{\cdot}003$ MeV and that of beryllium was found to be $1{\cdot}662 \pm 0{\cdot}003$ MeV. A.

539.172.3

9603. Independent particle model and the nuclear photoeffect. J. S. Levinger and D. C. Kent. *Phys. Rev.*, **95**, 418–24 (*July* 15, 1954).

The very low value calculated by Levinger and Bethe for the harmonic mean energy for the nuclear photoeffect is increased by a factor of 3 for Cu and 4 for Ta if correlations between nucleons due to the Pauli principle are included in the calculation using an independent particle model (IPM). The calculation removes the discrepancy between the sum-rule result and Burkhardt's calculation using the IPM for Cu. If a smaller nuclear radius is used, and the increase of mean energy due to exchange forces included, reasonable agreement is found between experimental results for Cu and Ta and the harmonic mean energies calculated for an IPM in a finite square well: i.e. 18 MeV for Cu and 12 MeV for Ta. A.

539.172.3

9604. Fine structure in the $C^{12}(\gamma, n)C^{11}$ and $O^{16}(\gamma, n)O^{15}$ activation curves. L. Katz, R. N. H. Haslam, R. J. Horsley, A. G. W. Cameron and R. Montalbetti. *Phys. Rev.*, **95**, 464–71 (*July* 15, 1954).

A careful examination of the $C^{12}(\gamma, n)C^{11}$ and $O^{16}(\gamma, n)O^{15}$ reactions, resulting from irradiating samples with betatron bremsstrahlung, has revealed discontinuities in the yields as a function of peak bremsstrahlung energy. These discontinuities are interpreted to indicate the presence of strong photon absorption levels in the C^{12} and O^{16} nuclei. In C^{12} the discontinuities were found at 19·3, 19·8, 20·1, 20·5, 20·7, 21·1, 21·6, 22·4 and 22·8 MeV, and in O^{16} they were found at 15·9, 16·4, 16·7, 16·9, 17·1, 18·9, 19·3, 20·7 and 21·9 MeV. The experimental results are discussed in detail and are interpreted qualitatively. A.

539.172.3

9605. Fine structure in the neutron yield curves from (γ, n) reactions in Li^7, C^{12}, O^{16}, and F^{19}. J. Goldemberg and L. Katz. *Phys. Rev.*, **95**, 471–5 (*July* 15, 1954).

Fine structure previously observed in the β^+ activation curves of C^{11} and O^{16} resulting from the betatron induced reactions $C^{12}(\gamma, n)C^{11}$ and $O^{16}(\gamma, n)O^{15}$ is shown to be present in the neutron yield curves from these reactions by detecting the emitted neutrons. The position of this fine structure as a function of betatron operating energy is the same in both cases to within experimental accuracy. The $Li^7(\gamma, n)Li^6$ and $F^{19}(\gamma, n)F^{18}$ were examined and discontinuities in the neutron yield curves were found at 9·6, 10·8, 12·4, 14·0 and 17·5 MeV for the first reaction and 11·0, 11·5, 11·9 and 15·3 for the second. A.

539.172.3

9606. Proton-neutron coincidences in the high-energy photodisintegration of lithium. M. Q. Barton and J. H. Smith. Letter in *Phys. Rev.*, **95**, 573–4 (*July* 15, 1954).

Photoneutron-photoproton angular correlations have been measured for lithium and deuterium targets irradiated by 265 MeV bremsstrahlung. The results favour the quasi-deuteron model proposed by Levinger [Abstr. 9709 (1951)]. J. J. WILKINS

539.172.3

9607. Photodisintegration of deuterium by 265-MeV bremsstrahlung. T. Yamagata, M. Q. Barton, A. O. Hanson and J. H. Smith. Letter in *Phys. Rev.*, **95**, 574–6 (*July* 15, 1954).

Differential cross-section measurements are reported for 45°, 75° and 120° laboratory angles and 140–260 MeV photon energies. The arrangement and performance of the five-crystal proton counter is described. J. J. WILKINS

539.172.3

9608. Neutrons in coincidence with high-energy photoprotons. H. Myers, A. Odian, P. C. Stein and A. Wattenberg. Letter in *Phys. Rev.*, **95**, 576–7 (*July* 15, 1954).

Photoneutron-photoproton angular correlations have been measured for both carbon and deuterium

irradiated by 325 MeV bremsstrahlung. The results favour Levinger's quasi-deuteron model [Abstr. 9709 (1951)]. J. J. WILKINS

539.172.3

9609. Angular distribution of photoelectrons produced by 0·4–0·8-MeV polarized photons. W. H. McMaster and F. L. Hereford. *Phys. Rev.*, **95**, 723–6 (*Aug.* 1, 1954).

The angular distribution of high-energy (0·4 to 0·8 MeV) photoelectrons produced in Pb and Au foils by linearly polarized photons has been investigated using scintillation counting and pulse-height analysis techniques. A Compton-scattered photon beam from Co^{60} provided a source of partially polarized radiation. Experimental results confirm the theoretical prediction of predominate photoemission orthogonal to the electric vector of the incident photon for photoelectron energies greater than 0·5 MeV. A.

539.172.3

9610. Photoneutron cross sections in He, N, O, F, Ne, and A. G. A. Ferguson, J. Halpern, R. Nathans and P. F. Yergin. *Phys. Rev.*, **95**, 776–80 (*Aug.* 1, 1954).

The direct detection of neutrons from (γ, n) reactions induced by betatron bremsstrahlung has been applied to cross-section determinations using gaseous targets at approximately 100 atmospheres pressure. Results from oxygen are consistent with other determinations. The remaining elements represent new results and show the familiar giant dipole resonance for the photoneutron process. Parameters of the resonances are determined and related to the systematic behaviour previously reported for other elements. A.

539.172.4

9611. On the energy-dependence of nuclear bombardment cross-sections for fast neutrons. M. Ageno. *R.C. Ist Super. Sanità*, **17**, *Pt IV*, 290–301 (1954) *In Italian.*

The nuclear cross-sections for fast neutrons have been recalculated by the Weisskopf method, assuming also within the nucleus the exact eigenfunctions (at constant potential), instead of their asymptotic expressions. A.

539.172.4

9612. Europium activation studies with monochromatic neutrons. R. E. Wood. *Phys. Rev.*, **95**, 453–5 (*July* 15, 1954).

Resonances in the europium slow-neutron cross-section at $-0{\cdot}011$, $+0{\cdot}327$, $0{\cdot}461$, $1{\cdot}055$, $2{\cdot}74$, $3{\cdot}35$ and $7{\cdot}36$ eV have been assigned to Eu^{151}. This was done by observing the intensity of the 9·3-hour activity of Eu^{152} produced as a function of neutron energy. The remainder of the europium resonances below 10 eV were assumed to be due to Eu^{153}; i.e. $1{\cdot}76$, $2{\cdot}47$, $3{\cdot}84$, $6{\cdot}25$ and $8{\cdot}98$ eV. The fraction of the compound nuclei decaying to the isomeric state of Eu^{152} was found to vary by a factor of four for different resonances in Eu^{151}. These fractions were obtained for six of the seven resonances in Eu^{151}. A.

539.172.4

9613. "Fast chopper" time-of-flight measurement of neutron resonances. F. G. P. Seidl, D. J. Hughes, H. Palevsky, J. S. Levin, W. Y. Kato and N. G. Sjöstrand. *Phys. Rev.*, **95**, 476–99 (*July* 15, 1954).

A high-resolution neutron velocity selector, or "fast chopper," has been constructed and is in routine operation at the Brookhaven reactor. It consists of a high-speed rotor that produces bursts of neutrons of about 1 μsec duration, together with a neutron detector at the end of a 20-metre flight path and circuits with which the time of flight is measured. The construction and operating characteristics of the equipment are described briefly. The methods that are used for analysis of sample transmission curves in the energy regions of good and of poor resolution are presented, together with curves used to correct for the effects of Doppler broadening and sample thickness. In the good resolution region the measured total cross-section in the vicinity of a resonance can be interpreted to give the total width Γ and $g\Gamma_n$. In the poor resolution region only the quantity $\sigma_0\Gamma^2$, which is proportional to $g\Gamma_n\Gamma$, is obtained. Measured parameters for levels in the 2 to 200 eV energy region are given for silver, iodine, thorium, gold, manganese, and cobalt. The results are compared with theoretical expectations. A.

539.172.4

9614. Total cross sections for high energy neutrons. V. Culler and R. W. Waniek. Letter in *Phys. Rev.*, **95**, 585 (*July* 15, 1954).

The high resolution of a neutron scintillator counter telescope has allowed an attenuation experiment with the continuum of $Be^9 + p$ neutrons (from the Harvard synchrocyclotron) to be made under good geometrical conditions; a proportion of the unattenuated and attenuated collimated neutron beam being suitably scattered into monitor and absorber telescopes. Total cross-section of various elements, including C, D and H, are given for neutrons of energy between 60 and 108 MeV. The lower energy points confirm the "Harwell dip" for lead. D. R. Chick

539.172.4

9615. Interactions of high energy neutrons in molybdenum. E. G. Silver and R. W. Waniek. Letter in *Phys. Rev.*, **95**, 586–7 (*July* 15, 1954).

Thin filaments of molybdenum were embedded in photographic emulsions exposed to the neutron beam from the 95 in. synchrocyclotron. The spatial angles and the true ranges in 250 events originating in the molybdenum were measured. Histograms of the ranges for singly charged particles, and of the angular distributions for singly and doubly charged particles are given. P. Rothwell

539.172.4

9616. Scattering of 14·1-MeV neutrons in helium, hydrogen, and nitrogen. J. R. Smith. *Phys. Rev.*, **95**, 730–5 (*Aug.* 1, 1954).

Cloud-chamber studies have been made of the scattering of 14·1 MeV neutrons in helium, hydrogen and nitrogen. For each of these gases the angular distribution of the elastically scattered neutrons has been obtained. The angular distribution in helium shows a minimum at about 110° in the centre-of-mass system, with a large maximum representing forward scattering and a smaller maximum for backscattering. The hydrogen angular distribution is isotropic.

Elastic scattering in nitrogen resembles diffraction scattering, showing a strong forward scattering maximum and smaller maxima at 70° and 180°, with minima close to 60° and 130°. Inelastic scattering in nitrogen does not depart from spherical symmetry by more than a factor or two. The elastic scattering cross-section for nitrogen is 0·82 barn and the inelastic scattering cross-section is 0·48 barn. Cross-sections for two- and three-particle disintegrations are 270 and 16 millibarns, respectively. A.

539.172.4

9617. n–γ coincidences produced by inelastic scattering of neutrons. P. Shapiro, V. E. Scherrer, B. A. Allison and W. R. Faust. *Phys. Rev.*, **95**, 751–3 (*Aug.* 1, 1954).

Scintillation spectrometer analysis of the γ-ray spectrum arising from interaction of 3·2 MeV neutrons with chromium shows several γ-rays including a very pronounced 1·43 MeV line. Coincidence observations indicate that there are a negligible number of γ-rays in cascade with the 1·43 MeV line. Thus the residual nucleus is left in the 1·43 MeV state by emission of a neutron which carries off the remaining portion of the energy. The energy distribution of this group of inelastically scattered neutrons as deduced from the coincidence pulse-height distribution of recoil protons in a stilbene detector has a maximum at 1·5 MeV. A.

539.172.4 : 539.152.1

9618. Neutron scattering and the weak-interaction model of the nucleus. J. M. C. Scott. *Phil. Mag.*, **45**, 751–7 (*July*, 1954).

Data on the scattering of slow neutrons are examined, using the theory of a previous paper, to see whether a size-resonance effect exists (of the kind which can be pictured qualitatively in terms of the crystal ball model). It is concluded that the effect is real, and that the resonances occur at the predicted values of the mass-number. It is also found that a single-particle wave-function for the incident neutron in the nucleus suffers less perturbation with medium weight nuclei than it does with heavy or light nuclei; there seems to be no obvious explanation. A.

539.172.4

9619. Measurement of reactivity in a pile. J. Bernot and V. Raievski. *J. Phys. Radium*, **15**, 359–65 (*May*, 1954) *In French.*

Reactivity determination by measurement of the counting rates in a neutron detector in a sub-critical pile (the Saclay D_2O reactor) is described. The counting rates are related to that corresponding to a known reactivity change obtained by lowering the D_2O a given amount below the critical level, with due care to ensure that the counting rate remains proportional to the mean neutron density in the reactor. L. R. Shepherd

539.172.4

9620. Distribution of thermal neutron density inside a natural-uranium-heavy-water cell. A. Ertaud and P. Zaleski. *J. Phys. Radium*, **15**, 75 A–77 A (*May Suppl.*, 1954) *In French.*

This was measured in a cell of the Chatillon pile, using autoradiography of Mn detectors. The diffusion length found was $L = 1{\cdot}24 \pm 0{\cdot}03$ cm [*cf.* 1·30 used by Guggenheim and Pryce, Abstr. 4374 (1953)]. A. O. Stanesby

539.172.4

9621. Determination of the transport mean free path of thermal neutrons in heavy water by means of a modulated source. V. Raievski and J. Horowitz. *C.R. Acad. Sci.* [*Paris*] **238**, 1993–5 (*May* 17, 1954) *In French.*

A mechanically modulated neutron source was placed in heavy water, and the amplitude and phase of the fluctuations in neutron density were measured at several points. A transport mean free path of $2{\cdot}45 \pm 0{\cdot}07$ cm was obtained, in good agreement with other published values. J. M. Cassels

539.172.4

9622. Some studies of uranium fission, using an automatic cloud chamber. H. de Laboulaye, C. Tzara and J. Olkowsky. *J. Phys. Radium*, **15**, 470–82 (*June*, 1954) *In French.*

The distribution in range of fission fragments in argon was obtained for 560 events. The probability of ternary fission with a short-range third fragment was (1 ± 3) per 1000 fissions, casting doubt on the much larger values of earlier workers. A. O. Stanesby

539.172.4

9623. Estimating radioactivity of irradiated uranium. R. L. Koontz and A. A. Jarrett. *Nucleonics*, **12**, 26–8 (*June*, 1954).

The calculation of the β- and γ-activities of fission products formed in neutron irradiation of uranium is outlined. Graphs and a nomogram, showing these activities as a function of irradiation and cooling time and integrated flux, are given, together with a curve showing the Pu^{239} α-activity which is produced. L. R. Shepherd

539.172.4

9624. Validity of the inverse velocity law for the fission cross section of ^{235}U. D. Popovic. *Physica*, **20**, 406–12 (*July*, 1954).

Cadmium-ratio measurements were used in order to check the validity of the $1/v$ law for fission of U^{235} in the resonance region. The fast fission effect was eliminated by measuring the transmission of epi-cadmium neutrons through nickel which has different cross-sections for resonance and fast neutrons. It was found that the $1/v$ law does not quite hold good in the resonance region, the resonance integral being ~ 20 barns. A.

539.172.4

9625. The multiplicity of neutron production by spontaneous fission of uranium. K. W. Geiger and D. C. Rose. *Canad. J. Phys.*, **32**, 498–508 (*Aug.*, 1954).

Metallic uranium was placed in a paraffin pile containing two $B^{10}F_3$ neutron counters. The mean life of thermal neutrons in this pile was measured (140 μsec). Neutron counter pulses occurring within a time interval of this order can be assumed to come from an individual fission event and statistical analysis makes it possible to obtain information concerning the actual number of neutrons released in one fission event.

The efficiency of the pile for neutron counting was found to be 2·5% using the known neutron rate from spontaneous fission of uranium. Without further assumption, the method does not give the mean multiplicity directly, but the higher moments of the multiplicity spectrum. A Poisson distribution for the multiplicity spectrum fits the data well and gives an average of $2{\cdot}3 \pm 0{\cdot}2$ neutrons per spontaneous fission. This value is in good agreement with the mean multiplicity from other methods. A.

539.172.4

9626. The fission yields of the stable and long-lived isotopes of xenon, cesium, and krypton in neutron fission of U^{233}. W. Fleming, R. H. Tomlinson and H. G. Thode. *Canad. J. Phys.*, **32**, 522–9 (*Aug.*, 1954).

The fission yields of Xe^{131}, Xe^{132}, Xe^{134}, Xe^{136}, Cs^{133}, Cs^{135}, Cs^{137}, Kr^{83}, Kr^{84}, 10·27 year Kr^{85}, and Kr^{86} in the neutron fission of U^{233} have been determined by mass spectrometer methods. The very pronounced fine structure in the mass yield curve in the mass range 131 to 137 found in U^{235} fission does not occur in the fission of U^{233}. This disappearance of fine structure would not have been predicted by any of the mechanisms which have been suggested to explain the fine structure in U^{235} fission. The fission yield of the 10·27 year isomer of Kr^{85} relative to the other krypton isotopes is considerably higher in U^{233} fission than in U^{235} fission, indicating some fine structure in this mass range which may be related to the closed shell of 50 neutrons. A.

ATOM AND MOLECULE BEAMS . MESONS NEUTRONS 539.18

539.18

9627. Recent results on *S*-particles. H. Bridge, H. Courant, B. Dayton, H. C. DeStaebler, Jr, B. Rossi, R. Safford and D. Willard. *Nuovo Cimento*, **12**, 81–9 (*July*, 1954).

Up to the present, 40 examples of *S*-particles have been photographed with the M.I.T. multiple cloud chamber. Examination of the pictures has yielded the following results. In three cases the charged secondary particles were found to have ranges of the order of 100 g cm^{-2} of lead. In three additional cases the secondary particles traversed more than 70 g cm^{-2} of lead before leaving the chamber. Shorter ranges were also found but, in interpreting these observations, one must consider the possibility of anomalous energy losses by nuclear collisions. In nine cases an electron cascade appears to be associated with the decay of an *S*-particle. It is possible to interpret these events as two-body decay processes into a neutral and a charged π-meson. Such a decay scheme, however, cannot explain all observed *S*-events. A.

539.18

9628. A new estimate of the lifetime of Λ^0-particles. D. I. Page. *Phil. Mag.*, **45**, 863–8 (*Aug.*, 1954).

A further estimate of the mean lifetime of Λ^0-particles has been made from measurements on 23 decay events. *V*-events have been selected in which the positive secondary particle can be identified as a proton from its momentum and ionization. The decay scheme for these events is assumed to be $\Lambda^0 \rightarrow P^+ + \pi^- + 37$ MeV. The result of the analysis of the events is a mean lifetime of $(3{\cdot}6^{+1{\cdot}1}_{-0{\cdot}7}) \times 10^{-10}$ sec. The weighted mean of all the published results is now $\tau = (3{\cdot}7^{+0{\cdot}9}_{-0{\cdot}5}) \times 10^{-10}$ sec. [See also Abstr. 1748 (1954)]. A.

539.18

9629. Experimental study of the μ^- meson mass and the vacuum polarization in mesonic atoms. S. Koslov, V. Fitch and J. Rainwater. Letter in *Phys. Rev.*, **95**, 291–2 (*July* 1, 1954).

X-rays emitted in transitions of μ^--mesons between atomic orbits about nuclei have been studied for the $2P$–$1S$ transition in carbon, the $3D$–$2P$ transition in phosphorus and the $4F$–$3D$ transition in silicon for transition energies below 90 keV. For such energies only nuclear size corrections and vacuum polarization effects are non-negligible. The upper and lower limits on the μ^--meson mass, calculated without and with the lowest-order vacuum polarization effect, are tabulated and the results would indicate the need to include vacuum polarization for getting agreement with the latest μ^--meson mass value of $206{\cdot}9 \pm 0{\cdot}2\, m_e$. G. Field

539.18

9630. Fermi's theory of the generation of pions and the partition theory of numbers. F. C. Auluck and D. S. Kothari. Letter in *Progr. theor. Phys.*, **11**, 120–1 (*Jan.*, 1954).

If an energy W is available to produce pions of rest mass μ and the maximum number of mesons which can be produced is then $\nu \leqslant W/\mu$, then the most probable number of pions produced k should be given by $p_k(\nu) =$ maximum, where $p_k(\nu)$ is the number of ways of partitioning a number ν- into k-integral parts. G. E. Brown

539.18

9631. Interpretation of results on "jets" of mesons. T.-F. Hoang. *J. Phys. Radium*, **15**, 337–44 (*May*, 1954) *In French.*

Analysis of 54 jets produced by proton and neutron primaries shows that they can be attributed to multiple production of mesons in a single nucleon-nucleon collision. The jets of low multiplicity are characterized by a coefficient of inelasticity with a mean value 0·41, whereas for jets of high multiplicity the coefficient is unity. The secondaries interact strongly with matter having a mean free path in the emulsion of 23^{+20}_{-10} cm. The integral spectrum of the proton primaries can be represented by a power law with exponent $1{\cdot}1 \pm 0{\cdot}2$. H. Elliot

539.18

9632. *K*-particle production by protons of 2·2 and 3·0 BeV. R. D. Hill, E. O. Salant and M. Widgoff. Letter in *Phys. Rev.*, **94**, 1794 (*June* 15, 1954).

Four *K*-particles have been observed in stacks of stripped emulsions exposed to radiations from a copper target bombarded by the proton beam from the Brookhaven cosmotron. Masses were determined from range, ionization and scattering measurements. A K^--meson, mass $970 \pm 150\, m_e$, and three

K^+-mesons, with masses in the range $1050 \pm 250\, m_e$, have been identified. A minimum value of lifetime of 2×10^{-9} sec is given. P. ROTHWELL

539.18

9633. Negative-to-positive ratio of photomesons from deuterium. M. SANDS, J. G. TEASDALE AND R. L. WALKER. Letter in *Phys. Rev.*, **95**, 592–3 (*July* 15, 1954).

Using 500 MeV bremsstrahlung, this has been measured for various meson energies (20–200 MeV) and angles (29°, 73° and 140°). The results lie between 1·0 and 1·8, being greatest at 140°.

J. J. WILKINS

539.18

9634. Observations on the associated production of heavy mesons and hyperons. C. DAHANAYAKE, P. E. FRANCOIS, Y. FUJIMOTO, P. IREDALE, C. J. WADDINGTON AND M. YASIN. *Phil. Mag.*, **45**, 855–62 (*Aug.*, 1954).

In a systematic search for *K*-mesons and hyperons produced in emulsions, two events have been found which appear to be due to the reaction $\pi + N \rightarrow Y + K$, where N represents a bound nucleon. The evidence suggests that such reactions play an important rôle in the production of heavy unstable particles. A.

539.18

9635. Meson physics. R. E. MARSHAK. *London: McGraw-Hill Publishing Co.* (1952) viii + 378 *pp.* [*International Series in pure and applied physics*].

Review in *Nature* [*London*] **174**, 97 (*July* 17, 1954).

539.18 : 537.591.8

Heavy unstable particles in stripped emulsions. *See Abstr.* 9371

539.18 : 778.34

Measurement of the mass of charged particles recorded in nuclear emulsions without support [pellicles] by grain counting. *See Abstr.* 9874

539.181

9636. On the large effective cross-section for the scattering through small angles in collisions between neutral atoms. W. JAWTUSCH, R. JAECKEL AND G. SCHUSTER. Note in *Z. Naturforsch.*, **9a**, 475–6 (*May*, 1954) *In German.*

Continuation of earlier work [Abstr. 5110 (1953)]. K atoms were scattered from Zn, Cd and Hg atoms and strong forward scattering was found with cross-sections many times the classical values. J. HUGHES

539.181

9637. Scattering of high-velocity neutral particles. IV. He–A; A–He. I. AMDUR, E. A. MASON AND A. L. HARKNESS. *J. chem. Phys.*, **22**, 1071–4 (*June*, 1954).

For Pt III, see Abstr. 6927 (1954). Total collision cross-sections have been measured for helium atoms with energies between 500 and 2100 eV, scattered in room temperature argon, and for argon atoms with energies between 600 and 2100 eV, scattered in room temperature helium. In each case, two detectors of different geometric aperture have been used, and potential energy functions have been obtained by procedures previously applied to helium scattered in helium. The average function for the potential energy between a helium atom and an argon atom derived from the measured cross-sections may be represented by $V(r) = 9{\cdot}95\times10^{-11}/r^{7{\cdot}25}$ ergs, for values of r between 1·64 Å and 2·27 Å. Since this potential is in good agreement with the geometric mean of the potential between two helium atoms and that between two argon atoms in the range represented by the arithmetic average of the individual interaction distances, it is suggested that the parameters of a point repelling type potential function may, in general, be combined in this manner. A.

539.185

9638. Resonance absorption of neutrons in sodium. D. POPOVIĆ. Letter in *Nuovo Cimento*, **12**, 143–4 (*July*, 1954) *In Italian.*

The "cadmium ratios" for boron and sodium were measured, using the collimated neutron beam from the JEEP reactor, and the resonance absorption integral for sodium was calculated, from the difference between the two ratios, as $\Sigma_Q = 0{\cdot}037$ barn.

P. ROTHWELL

539.185

9639. Two-group perturbation theory in neutron transport theory. J. H. TAIT. *Proc. Phys. Soc.* [*London*] *A*, **67**, 615–21 (*July*, 1954).

Describes the application of perturbation theory to two-velocity-group neutron problems. The exact integral equations are considered satisfied by the neutron densities. The treatment is, therefore, not restricted to systems whose dimensions are large compared with the relevant mean free paths, and is more general than that reported by Glasstone and Edlund [Abstr. 7939 (1953)]. The latter describe a theory, due to Wigner, in which it is assumed that the neutron densities satisfy the diffusion equations, i.e. the theory is applicable only to large systems. The eigenfunctions of the integral equations do not form an orthogonal set. They are orthogonal to the eigenfunctions of the adjoint equations. The first part of the paper deals with the construction of these latter equations. The variation of the eigenvalue of the integral equations with small changes in the system is calculated. Finally formulae are obtained for the multiplication of a source of neutrons in a system near to critical. The theory described in this paper is a generalization of that given by Fuchs [Abstr. 2001 (1950)] for application to one-group-theory problems. The pattern of the analysis is similar, but deviates in the treatment of the effect of a change in the neutron mean free path in the system. A.

539.185

9640. Polarization in high-energy *p–n–n* double scattering. P. HILLMAN, V. CULLER AND N. F. RAMSEY. *Phys. Rev.*, **95**, 462–3 (*July* 15, 1954).

An exploratory polarization experiment on the double scattering of high-energy neutrons has been performed. A 100 MeV proton beam gives exchange neutrons in the first scattering, and these neutrons are rescattered and counted. Two high-efficiency liquid scintillation counters are used to detect the neutrons, which have an average effective counted energy of about 45 MeV. Various combinations of scatterers were used. In all cases the asymmetry $2e$ was less than 6%. A.

539.185

9641. An easily reproducible standard of thermal neutron density. R. COHEN AND R. BARLOUTAUD. *C.R. Acad. Sci.* [*Paris*] **238,** 2413–14 (*June* 21, 1954) *In French.*

Definition of the proposed standard is: that density of thermal neutrons which produces, in a copper disk, dia. 15·00 mm, weighing 500 mg/cm², a saturation activity of Cu^{64}, which gives a counting rate, in a 4π counter, of one pulse/sec. The absolute value of this density is $(5{\cdot}7 \pm 0{\cdot}19) \times 10^{-3}$ neutrons/cm³. The standard is reproducible to better than 1·5% accuracy. P. ROTHWELL

539.185

9642. The elastic scattering of neutrons by alpha particles. B. H. BRANSDEN AND J. S. C. MCKEE. *Phil. Mag.*, **45,** 869–80 (*Aug.*, 1954).

The theory of the scattering of neutrons by α-particles is formulated using the variational method. It is assumed that the five-body wave-function can be written in the Wheeler resonating group form and allowance is made for possible two-body spin orbit coupling. Detailed numerical calculations of the *S*-wave phase shifts for incident neutrons below 7 MeV, and of the zero energy cross-section, are presented for two-body potentials having the exchange properties of an ordinary, a Majorana–Heisenberg exchange, a symmetrical exchange and a Serber interaction. Comparison of the theoretical results with experimental data strongly favours forces of the Majorana–Heisenberg or symmetrical exchange type against those of the ordinary and Serber types. A.

539.185

9643. The scattering of 15·7 MeV neutrons by ^{4}He. M. H. ALSTON, A. V. CREWE, W. H. EVANS, L. L. GREEN AND J. C. WILLMOTT. *Proc. Phys. Soc.* [*London*] *A*, **67,** 657–62 (*Aug.*, 1954).

The angular distribution of the α-particles from collisions with 15·7 MeV neutrons has been studied using a diffusion cloud chamber. The results indicate that a $D_{5/2}$ phase shift slightly smaller than the hard sphere value must be used to obtain the best fit. A.

539.185.08

9644. Recent developments in film monitoring of fast neutrons. J. S. CHEKA. *Nucleonics*, **12,** 40–3 (*June*, 1954).

A film badge (NTA type) having a 30 μ emulsion on a film base of 28·5 mg/cm² (range of a 4·37 MeV proton) was found to have a response varying with neutron energy in the same way as dose rate, up to 3·5 MeV. Modifications to the film wrapping, involving the use of successive layers of Al and cellulose, extended the range of dose rate equivalence up to 14 MeV. It was found that the latent image stability of the emulsion was greatly improved by storing the exposed undeveloped films in a desiccator. L. R. SHEPHERD

539.185.08

9645. A scintillation detector for fast neutrons. L. W. SEAGONDOLLAR, K. A. ESCH AND L. M. CARTWRIGHT. *Rev. sci. Instrum.*, **25,** 689–91 (*July*, 1954).

A fast neutron detector has been prepared by suspending ZnS phosphor powder in "Bio-Plastic." The detector can be easily prepared using only simple laboratory equipment. In the presence of the γ-rays from a Ra–Be source, the neutrons from the source can be counted using this detector with about 1% efficiency. A.

539.185.08 : 537.542

A multiple-wire proportional counter for fast neutron detection. *See Abstr.* 9326

STRUCTURE OF SOLIDS 539.2

539.211

9646. The fracture of metals. N. J. PETCH. *Progress in metal physics, Volume* 5, 1–52 (1954) [see Abstr. 9871 (1954)].

A comprehensive review discussing the following topics: Griffith theory, nature of Griffith cracks in glass, types of metallic fracture, criteria for metallic fracture, Griffith cracks in metals, fracture under biaxial and triaxial stresses, initiation and propagation of cleavage, metallurgical features of cleavage and intercrystalline fracture, adiabatic fracture, plastic fracture, delayed fracture (static, dynamic loading), size and statistical effects, thermodynamic considerations. 177 references. E. P. WOHLFARTH

539.213

9647. Modern theories and methods of studying the vitreous state. I. PEYCHES. *Bull. Soc. Franç. Minéral Crist.*, **77,** 362–94 (*Jan.–March*, 1954) *In French.*

Review article on the structure of silica glasses. The question of whether or not crystallites exist in a glass is discussed in the light of the earlier work of Zachariasen and Warren and also some more recent information (including electron diffraction and infrared absorption data). The rôle of modifier ions in breaking network bonds is also studied. Finally, some possible explanations for the permanent change in volume induced by high pressures [Bridgman and Simon, Abstr. 4435 (1953)] are put forward. R. O. DAVIES

539.213

9648. On the transitional phenomena of glass. E. KANAI AND T. SATOH. *J. Phys. Soc. Japan*, **9,** 417–24 (*May–June*, 1954).

A new interpretation of the glassy state, which includes the explanation of transitional phenomena, is proposed on the basis of the superposition of the two modes of motion, one of which is the network deformation and another is the vibration around the instantaneous configuration of the network. To formulate this idea, a new parameter, the "network temperature," is introduced and the thermodynamical treatment carried out, with independent derivation of the equation of motion. Finally, some experimental data are checked with this theory and its validity is discussed. A.

539.213 : 534.23

On the elastic absorption of amorphous materials. *See Abstr.* 9010

539.215.5

9649. Another form of alpha ferric oxide. F. A. STEELE. *J. Colloid Sci.*, **9,** 166–74 (*April*, 1954).

539.215.7

9650. Covering of a plane surface with granular material. Z. Bodó and I. Hangos. *Acta. phys. Hungar.*, **3**, *No.* 3–4, 155–69 (1954).

The covering was determined theoretically and checked experimentally for samples of homogeneous grain size. The extension of the results to powder mixtures is also discussed. A.

539.216.1 : 535.42

9651. The structure and optical behaviour of some natural and synthetic fibres. C. V. Raman and M. R. Bhat. *Proc. Indian Acad. Sci. A*, **39**, 109–16 (*March*, 1954).

When a narrow pencil of light which comes to a focus in the plane of a photographic film traverses a single fibre set transversely to it in its path, the light diffracted by the fibre in various directions records itself on the film when adequate exposures are given. Photographs thus obtained with single fibres of cotton, wool, silk, rayon and chrysotile are reproduced. The birefringence of the fibres exhibits itself by the non-disappearance of the pattern when two polaroids crossed with respect to each other are placed one on either side of the fibre, the axis of the latter bisecting the angle between their vibration directions. The diffraction patterns indicate the inner structure of the fibres and are strikingly different for the different materials. A.

539.217

9652. Volume changes in the diffusion zone in oxide systems. W. A. Fischer and A. Hoffmann. Note in *Naturwissenschaften*, **41**, *No.* 7, 162–3 (1954) *In German.*

Interdiffusion of spinel ($FeO.Al_2O_3$) and pure Al_2O_3 shows the Kirkendall effect and the production of pores in the Al_2O_3. It is concluded that the Al ions diffuse more rapidly than the Fe. W. M. Lomer

539.217 : 530.162

9653. Statistical mechanics of two-component interstitial solid solutions. A. L. G. Rees. *Trans Faraday Soc.*, **50**, 335–42 (*April*, 1954).

The pressure-temperature-composition relations for two-component interstitial solid solutions have been derived by a statistical mechanical method. The physical model requires all non-metal atoms to occupy interstitial sites in a perfect parent metal lattice, to which all changes are referred. The neglect of changes in lattice symmetry and cell dimensions with change of composition does not introduce serious errors. A refinement of the model takes into account the reduction in the number of available interstitial sites brought about by disorder in the parent lattice; this is suggested as the explanation of the experimental observation on some metal hydride systems that the saturation solubility decreases as the temperature increases. The theory is applicable to any non-stoichiometric system in which one component is volatile or gaseous. A.

539.217 : 530.162

9654. Interpretation of the solubility of hydrogen in zirconium. S. L. H. Martin and A. L. G. Rees. *Trans Faraday Soc.*, **50**, 343–52 (*April*, 1954).

The pressure and temperature dependence of the solubility of hydrogen in zirconium and zirconium + oxygen solid solutions has been interpreted in terms of a statistical-mechanical theory of two-component interstitial solid solutions. The interpretation is consistent with the X-ray data on the phases in the Zr + H system. The two-phase region lying between the compositions ZrH and ZrH_2 is reproduced satisfactorily in the calculated isotherms. The derived energy parameters lead to a value for the heat of formation of ZrH_2 of 41·4 kcal $mole^{-1}$, in good agreement with the value determined calorimetrically. The effect of oxygen on the initial solubility of hydrogen in zirconium appears to be due to the blocking of sites normally available to hydrogen atoms by neighbouring oxygen atoms; the saturation solubility is determined by the amount of free metallic zirconium remaining after separation of the oxygen as ZrO_2. A.

539.217 : 539.26

9655. The surface migration of carbon on tungsten. R. Klein. *J. chem. Phys.*, **22**, 1406–13 (*Aug.*, 1954).

The surface migration of carbon on tungsten was observed with the field-emission microscope technique. The tungsten point was shadowed with carbon and heated to a given temperature; observations of the emission patterns were made at room temperature at various time intervals. The migration occurs at a measurable rate starting about 850°K. It is characterized by a sharp boundary of a form which clearly shows that the (011) and (121) planes are avoided. An activation energy of 55 ± 7 kcal/mole was calculated for the process by application of the theory of diffusion with a sharp moving boundary. A.

539.217 : 548

9656. The lattice spacings of lead-rich substitutional solid solutions. C. Tyzack and G. V. Raynor. *Acta cryst.*, **7**, 505–10 (*July*, 1954).

The lattice-spacing/composition curves for the lead-rich alloys of lead with antimony, bismuth, tin, indium, thallium, cadmium and mercury have been determined. Only bismuth expands the lead lattice. The distortions produced by equiatomic percentages of solute depend on the relative atomic volumes and relative valencies of the solute and solvent metals. Thus, for the solute metals of the second long period of the Periodic Table, the contractions produced by equal atomic percentages of solute decrease in the order cadmium, indium, tin, antimony; this is also the order in which the group valencies and the atomic volumes of the solute metals increase. Similarly, for mercury, thallium and bismuth, the contraction caused by mercury is greater than that caused by the same atomic percentage of thallium, while bismuth, the only solute for which the atomic volume is greater than that of lead, expands the lattice. The results are discussed with particular reference to the effect on lattice-spacing relationships of differences in atomic size and valency between the solute and solvent metals. No simple correlations are observed; it is concluded that lattice spacings in lead alloys are influenced by some factor connected with the electronic structures of the underlying ions of the component metals, in addition to factors already recognized in alloy systems based on solvent metals of lower valency and smaller atomic number. A.

539.219

9657. Some properties of germanium-silicon alloys. E. R. JOHNSON AND S. M. CHRISTIAN. Letter in *Phys. Rev.*, **95**, 560–1 (*July* 15, 1954).

Homogeneous alloys of Si and Ge were prepared, and composition, density, lattice constant and forbidden band gap determined. The density varies linearly with composition within the experimental accuracy, but the lattice constant curve lies entirely below the linear join of Si and Ge values, with a max. deviation of 0·2%. The band gap rises steeply from the value for pure Ge up to some 10 mol % Si, when there is a sharp change of slope followed by a slower rise to the value for pure Si. W. M. LOMER

539.234

9658. Preparation, properties and optical applications of thin films of titanium dioxide. G. HASS. *Vacuum*, **2**, 331–45 (*Oct.*, 1952) [*Publ. March*, 1954].

Presents data on the optical properties, structure and oxidation of evaporated titanium films and discusses the structure, properties, and applications of titanium dioxide coatings prepared by heat oxidation of vacuum deposited titanium and by decomposition of titanium tetrachloride with atmospheric water vapour. It is shown that the rate of deposition and the pressure in the evaporation unit influence greatly the structure and optical properties of evaporated titanium films and of titanium dioxide coatings prepared by heat oxidation of evaporated titanium. Pure titanium films can only be deposited by fast evaporation at good vacuum. Slow evaporation at poor vacuum results in TiO–TiN films with cubic structure. The oxidation of pure titanium films in air at 400° to 450°C results in titanium dioxide films with rutile structure and high *n*-values while "poorly deposited titanium films" oxidize at the same temperature to titanium dioxide films with anatase structure and much lower *n*-values. Rutile is especially suitable as a top film in multilayer combinations. Titanium dioxide films produced by fuming titanium tetrachloride on to hot glass are amorphous if the glass temperature is kept below 280°C and consist of anatase at higher temperatures. An anodic method for applying reflectance-increasing film pairs of aluminium oxide and titanium dioxide on aluminium mirrors is described. A.

539.234

9659. Influence of the condensing surface on the values of the condensation factor of molecular jets of antimony and gold. M. DEVIENNE. *C.R. Acad. Sci.* [*Paris*] **238**, 2397–9 (*June* 21, 1954) *In French.*

See Abstr. 3022 (1952) for description of apparatus. The condensation factor of Sb on glass falls with increasing temperature and increases with increasing thickness of deposit (e.g. 0·122 at 125°C, thick deposit). The factor for deposition on Cu is higher (0·201 at 265°C on a thin layer). The condensation factor of Au on glass, Cu and Al exceeds 0·9 at ordinary temperatures, but falls off slightly in the case of deposition on Cu and considerably in the cases of deposition on glass and Al as the temperature is raised. N. CORCORAN

539.234 : 533.59

9660. Notes on solution of problems in odd job vapor coating. W. L. BOND. *J. Opt. Soc. Amer.*, **44**, 429–38 (*June*, 1954).

Charts are presented for the solution of the problems pertaining to vapour coating in general. These charts are intended to be adequate to explain and describe the conditions necessary to produce high-quality metal coatings of given optical transmission and given electrical resistance as well as given thicknesses or given weight per unit area. A.

539.26

9661. The contributions to the study of textile fibres by means of X-rays. J. J. TRILLAT AND C. LEGRAND. *Bull. Soc. Franç. Mineral. Crist.*, **77**, 302–22 (*Jan.–March*, 1954) *In French.*

A review article. The principal characteristics of X-ray photographs of fibres are described, together with the type of information that can be derived from them. The limitations of this method are discussed and it is emphasized that other methods both practical and theoretical are necessary for a proper resolution of the problems of the structure of organic fibres. A. D. LE CLAIRE

539.26

9662. Anomalous structure of α–AgI. S. HOSHINO. Note in *J. Phys. Soc. Japan*, **9**, 295 (*March–April*, 1954).

Two hypothetical structures are assumed, each with the iodine atoms on a b.c.c. lattice; but in one, an ordered structure, the Ag atoms are at $(0, \frac{1}{2}, \frac{1}{4})$ $(\frac{1}{2}, 0, \frac{3}{4})$; and in the other, a disordered structure, the Ag atoms are distributed randomly over the 12 equivalent sites of the type $(0, \frac{1}{2}, \frac{1}{4})$. The measured background and line intensities in the X-ray pattern of a powder sample of α.AgI are well matched by those calculated for a structure intermediate between these two with degree of order 0·8. A. D. LE CLAIRE

539.26

9663. An X-ray study of thin evaporated films of metal. M. MIWA AND S. ANNAKA. Note in *J. Phys. Soc. Japan*, **9**, 302 (*March–April*, 1954).

A study of X-ray diffraction (transmission) photographs of thin oriented films of Ag, Au and Al evaporated on to heated rock-salt cleavage faces *in vacuo*. The films are removed from the substrates by solution of the rock salt. For Ag and Au spots and streaks are observed which arise from repeated twinning on (111) planes. No anomalous effects are observed for Al. J. THEWLIS

539.26

9664. Surface studies of solids by total reflection of X-rays. L. G. PARRATT. *Phys. Rev.*, **95**, 359–69 (*July* 15, 1954).

Analysis of the shape of the curve of reflected X-ray intensity *v.* glancing angle in the region of total reflection provides a new method of studying certain structural properties of the mirror surface about 10 to several hundred Ångströms deep. Dispersion theory, extended to treat any (small) number of stratified homogeneous media, is used as a basis of interpretation. Curves for evaporated copper on glass at room temperature are studied as an example. These curves may be explained by assuming that the

copper (exposed to atmospheric air at room temperature) has completely oxidized about 150 Å deep. If oxidation is less deep, there probably exists some general reduction of density (e.g. porosity) and an electron density minimum just below an internal oxide seal. This seal, about 25 Å below the nominal surface plane, arrests further oxidation of more deeply-lying loose-packed copper crystallites. All measurements to date have been carried out under laboratory atmospheric conditions which do not allow satisfactory separation or control of the physical and chemical variables involved in the surface peculiarities. The method, under more controlled conditions of preparation and treatment of the surface, promises to be useful. A.

539.26 : 539.11

9665. The germanium–oxygen system. M. Hoch and H. L. Johnston. *J. chem. Phys.*, **22**, 1376–7 (*Aug.*, 1954).

High-temperature X-ray diffraction patterns of germanium plus germanium oxide GeO_2 between 750° and 1400°C, showed that germanium monoxide GeO is not a stable compound. At elevated temperatures germanium can dissolve up to 60 atom percent of oxygen. The oxygen causes first a slight expansion and then a contraction of the Ge lattice. At 850° and 930°C, the X-ray pattern of a germanium–oxygen compound, consisting of equimolecular quantities of germanium and oxygen, showed only the germanium pattern. At 1000° and higher (above the melting point of pure germanium, 965°C), the germanium pattern disappears, and liquid-like structure is visible, though the sample is still solid (melting point 1430°C). When the temperature is lowered again to 930°C, the germanium pattern reappears. The electrical resistivity of the Ge and GeO_2 mixture shows a sharp break at 970°C. In the germanium–oxygen compound there is thus a disordering of the germanium lattice above the melting point of pure germanium. A.

539.26 : 539.4.016.2

9666. X-ray study of cold work in some ordered alloys. S. Annaka. *J. Phys. Soc. Japan*, **9**, 354–8 (*May–June*, 1954).

The structure changes due to cold work on polycrystalline specimens of superlattice alloys ($AuCu_3$, AuCu, AgCd and AgZn) were studied by X-rays. In $AuCu_3$ and AuCu, a small anti-phase domain and strain were found to be produced by cold work. In AgCd and AgZn, the ε and ζ phases both changed into the β' phases by cold work even at room temperature, and in the case of the ε phases severe slipping along the (001) plane as well as atomic diffusion took pace during and after cold work. A.

539.27

9667. Electron diffraction study of transformations of thin layers of TiO_2, under the influence of temperature. P. Conjeaud. *C.R. Acad. Sci.* [*Paris*] **238**, 2075–6 (*May* 24, 1954) *In French.*

TiO_2, formed in thin layers by evaporation on a cold support, occurs in the amorphous state. On heating to 550°C it changes to anatase or, more often, a mixture of anatase and rutile. Above 800°C it exists only in the form of rutile. Brookite is never observed. J. THEWLIS

539.27

9668. Spin-coated polyvinyl alcohol replicas for electron microscope use. F. E. Bulette. Letter in *J. appl. Phys.*, **25**, 810–11 (*June*, 1954).

The long setting time of polyvinyl alcohol (24 hours) is a serious disadvantage to its use as a replicating material. A method is described which reduces this time to 10 minutes by spinning the specimen after coating on a turntable rotating at 600 r.p.m. No loss in resolving power results. Micrograms illustrating the results are given. M. E. HAINE

539.27

9669. Application of Ellis' theory on plural electron scattering to razor edge. S. Yamaguchi. Letter in *J. appl. Phys.*, **25**, 811–13 (*June*, 1954).

The edge of a razor blade is a convenient test specimen in the form of a truncated wedge for testing, by electron diffraction, Ellis's theory of plural scattering of electrons [Abstr. 8255, 9088 (1952)]. The thickness of the edge is measured in an optical reflection microscope and the contrast of a (200) α-iron ring is studied as a function of the voltage in the range 68–194 kV for different thicknesses of edge. The results agree with Ellis's observations on Al. J. W. MENTER

539.27 : 537.583

9670. Electronmicroscopic observation of the change of forms of the coated oxide particles of the oxide cathode by the activation. T. Hibi. *Sci. Rep. Res. Insts Tôhoku Univ. A*, **5**, 573–80 (*Dec.*, 1953).

In order to confirm whether the mutual relation exists between the degree of activation of the oxide cathode and the external form of the oxide particles, samples whose emission values were large, medium and small and those obtained from artificially deactivated oxide cathodes were examined using the electron microscope. Barium carbonate particles were also used as direct samples for the electron microscopic observation. As the results, it was ascertained that the form of an oxide particle gradually changed with the change of the activity. A.

539.27 : 537.583

Electron diffraction from thin films of barium oxide. *See Abstr.* 9345

539.27 : 539.23

9671. Electron-diffraction study of liquid-solid transition of thin metal films. M. Takagi. *J. Phys. Soc. Japan*, **9**, 359–63 (*May–June*, 1954).

Structure changes of thin films of Pb, Sn and Bi at various temperatures has been studied by electron diffraction method. The films were prepared in the electron diffraction camera by evaporating the metals on cleavage surfaces of several kinds of crystals. The mean thickness of the films ranged from 10 Å to 1000 Å. The observed melting points are found to be lower than those of bulk metals. Anticipating this effect to be attributed to the small size of the crystal, the author has calculated the melting temperature as a function of crystal size. The observed values of the lowering of the melting point agree fairly well with the calculated values for the crystal sizes estimated from the mean thickness and the breadth of the Debye–Scherrer rings in diffraction patterns. On cooling, the films are supercooled down to con-

siderably lower temperatures which can be ascribed to the slowness of the rate of nucleation in a small crystal. A.

539.27 : 548.74

9672. On plane-lattice effects in electron diffraction investigations on various metal layers. H. Jahrreiss. *Ann. Phys.* [*Leipzig*] **14,** *No.* 6–8, 319–40 (1954) *In German.*

Extra lines, observed by Cochrane [*Proc. Phys. Soc.* [*London*] **48,** 723 (1936)] and attributed by him to lamellae occurring between twinned crystals, are investigated. Other possible explanations are discussed, in particular the effect of an imperfect lattice. J. THEWLIS

539.27 : 548.74

The diffuse scattering of electrons by the thermal elastic waves in crystals. *See Abstr.* 9791

ELASTICITY . STRENGTH . RHEOLOGY 539.3/.8

539.31 : 534.012

9673. The propagation of longitudinal elastic waves along cylindrical bars. H. Kolsky. *Phil. Mag.*, **45,** 712–26 (*July*, 1954).

The elementary theory of longitudinal waves in bars predicts that such waves travel with a constant velocity $c_0 = (E/\rho)^{1/2}$. The Pochhammer theory shows that this is true only for waves of wavelength large compared with the diameter of the bar. Shorter waves travel more slowly, the limiting value being that of Rayleigh surface waves. When a disturbance is started at a point on one end-face of a cylinder, however, a spherical wave will travel out with the dilatational velocity c_1, and some energy should therefore travel along the bar with this velocity. Minute explosive charges have been used to produce elastic pulses and the propagation of such pulses down steel cylinders of various diameters has been investigated. The waves arriving at the opposite end of the cylinder were recorded with a cathode-ray oscillograph. It was found that whilst most of the energy travels at a velocity less than c_0 there are also *precursor* waves of small amplitude which travel with velocities between c_0 and c_1. For long cylinders it was found that the pulse arriving at the detector had a tail of low frequency oscillations, indicating that higher modes of vibration are being excited. A.

539.31 : 550.341

9674. An investigation of finite strain in an isotropic material subjected to hydrostatic pressure and its seismological applications. A. Keane. *Austral. J. Phys.*, **7,** 322–33 (*June*, 1954).

An attempt is made to reduce the generality of the usual theories of finite strain and to concentrate on the case of hydrostatic pressure. The method used has been based on the works of Murnaghan (1951) and Birch (1952), and yields a general relation giving the elastic constants in terms of the strain and the derivatives of pressure with respect to strain. It becomes evident that a law in lieu of Hooke's law is needed to proceed with a mathematical theory; and so various elasticity equations in the literature are investigated to determine the special assumptions used to derive them from the present general equations. A linear relation between the second- and third-order elastic constants is then proposed and the resulting relation between pressure and density compared with Bridgman's experimental results for the alkali metals. It is found that the proposed law of finite hydrostatic strain agrees favourably with experiment and also with deductions from the atomic theory of solids. The paper concludes with a few relevant remarks on the implications of the present theory to certain seismological problems. A.

539.319 : 621.012.8 : 621.3.011

9675. Extension of the corrected system of electromechanical analogies to continuous isotropic media. I. Malecki. *Arch. Elektrotech.* [*Warsaw*] **2,** *No.* 1–2, 23–66 (1953) *In Polish.* Summary (4 *pp.*) *in English.*

A theoretical study dealing with lossless isotropic media, under the assumption that the initial stresses are absent and the disturbances do not exceed the limits of proportionality. Elastic stress and strain fields are defined in terms of vector and scalar potentials, this procedure permitting a separation of the sourceless and irrotational field components. It is shown that the tangential stress and strain field is equivalent to magnetic field, whereas the normal elastic field is analogous to electric field. The validity of the proposed system of analogies is corroborated by: (1) the similarities existing between the boundary conditions in the elastostatic and magneto- and electrostatic fields; (2) the similarities between the spatial distributions of fields; (3) a close correspondence between the energy relationships in the two systems of fields. The analogies may also be applied to time varying processes; a certain mismatch in the system of analogies, which appears in this case, may be eliminated by a proper choice of operating frequency and scale for an electrical model. The article contains 24 references. R. S. SIDOROWICZ

539.32/.37

9676. Relations between the elastic moduli and the plastic properties of polycrystalline pure metals. S. F. Pugh. *Phil. Mag.*, **45,** 823–43 (*Aug.*, 1954).

Relations between the elastic and plastic properties of pure polycrystalline metals are discussed and a systematic relation between shear modulus, Burgers vector and plastic shear strength of metals possessing the same lattice structure is proposed. In addition reasons are given for believing that in a limited temperature range malleability is related to Poisson's ratio. A.

539.32 : 534.22

Electro-acoustic measurement of modulus of elasticity. *See Abstr.* 9002

539.32 : 541.182.5

9677. Elastic constants of gels. M. Krishnamurthi and G. S. Sastry. Letter in *J. chem. Phys.*, **22,** 1133 (*June*, 1954).

These were determined for silica and alumina-silica gels by a dynamic ultrasonic method [Abstr. 5366 (1954)]. Poisson's ratio is positive for both gels.

The results show that a gel simulates a liquid in its inability to propagate torsional waves. W. GOOD

539.374

9678. Geometrical aspects of the plastic deformation of metal single crystals. R. MADDIN AND N. K. CHEN. *Progress in metal physics*, *Volume* 5, 53–95 (1954) [see Abstr. 9871 (1954)].

A comprehensive review discussing the following topics: (1) f.c.c. metals: formation of slip lines, effect of orientation, temperature and rate of strain on the properties of slip lines, heterogeneity of gliding; (2) b.c.c. metals: appearance of glide traces, Laue asterisms, determination of glide elements, deformation bands, delay time experiments, crystallographic mechanisms of glide; (3) c.p.h. metals: results are discussed for the following metals: Zn, Cd, Ti, Be, Mg; (4) other metals: Hg, U, Si, Ge, Sn. 128 references. E. P. WOHLFARTH

539.377

9679. Temperature variation of Young's modulus, elastic limit and critical shearing stress of aluminium single crystal plates. T. YAMASHITA. *J. Sci. Hiroshima Univ. A*, **17**, 245–9 (*Dec*, 1953).

The influence of temperature upon Young's modulus, the elastic limit and the critical shearing stress of aluminium single crystal plates [100]–(110), [111]–(110), [110]–(110), [110]–(100) and [210]–(100) has been examined by obtaining the stress-strain curves at 15°C, 100°C, 200°C and 300°C. The following results were obtained: that the values of the Young's modulus and elastic limit of the principal crystallographic axes decreased with the rising temperature, and that such decreasing behaviour was different according to the crystallographic orientation. Moreover, it has been ascertained that the critical shearing stress also decreases with temperature. A.

539.4 : 541.183

9680. Variation of the influence of adsorbed gases on the mechanical strength of metallic wires as a function of their diameter. A. CLAUSS. *C.R. Acad. Sci.* [*Paris*] **239**, 25–7 (*July* 5, 1954) *In French.*

The fractional decrease in breaking strength of wires of silver and tungsten in atmospheres of CO_2, A and H_2 is shown to depend on the diameter of the wire and the material of the wire. The magnitude is also related to the liquefaction point of the gas. W. M. LOMER

539.4.013.3

9681. Triaxial stresses caused by notches. A. F. C. BROWN. *Brit. J. appl. Phys.*, **5**, 280–4 (*Aug.*, 1954).

The purpose of the work described was to give metallurgists a guide on means of suppressing plastic deformation in ductile materials, so as to provide a test for brittleness. Stress analyses were made on round bars with circumferential notches by the photoelastic frozen stress method and mechanical tests on steel test pieces provided additional information. An important conclusion is that, from the point of view of suppressing general yielding, the stress distribution at the middle of the bar has much more effect than that at the root of the notch. There is a need for further work on other shapes of notch. A.

539.4.016.2

9682. Deviations from Matthiessen's rule for cold-drawn wires. G. J. OGILVIE AND W. K. CLOTHIER. *Austral. J. Phys.*, **7**, 210–16 (*March*, 1954).

An a.c. bridge method of high accuracy has been developed to measure deviations from Matthiessen's rule. Deviations have been shown to exist in cold-drawn wires of copper, aluminium, bronze and 80/20 brass. A.

539.4.016.2

9683. Annealing of cold worked metals. P. A. BECK. *Advances in Phys.*, **3**, 245–324 (*July*, 1954).

A comprehensive review of experimental investigations during the past few years on the processes whereby the well-annealed condition may be approached. The evidence for distinguishing three distinct mechanisms for the release of stored energy is presented critically: (1) recovery, without any detectable grain-interface migration, which is especially important at low temperatures of deformation; (2) sub-grain growth, which can be greatly increased by external stresses; and (3) recrystallization. References. J. G. OLDROYD

539.4.016.2 : 536.631

9684. Effects of cold working on specific heat of metals. S. NISHIOKA. *Mem. Coll. Sci. Univ. Kyoto A*, **27**, 35–40 (*April*, 1953).

Effects of cold working on the specific heats of constantan, brass and copper have been studied experimentally. It has thus been shown that the effect could not be recognized for the above metals. The effects of cold working on specific resistance, density and thermal expansion have also been investigated for the same metals. Richarz's law as well as Geiss and Liempt's relation have been studied. A.

539.53 : 539.434

9685. The influence of creep on the measured hardness of soft metals. C. RUBENSTEIN. *Proc. Phys. Soc.* [*London*] *B*, **67**, 563–8 (*July*, 1954).

The influence of creep during the indentation process on the measured hardness of soft metals at room temperature is described. A modification to Dushman's creep equation is proposed, which is applicable to the conditions obtaining during indentation of a soft metal by a spherical indenter. The modified equation is used to derive a relation involving the Meyer hardness and the diameter of the indenter, which agrees satisfactorily both with published experimental data and with data obtained by the author. Numerical values of the Dushman constant α for lead and indium, obtained from this analysis of hardness measurements, are in reasonable agreement with values derived in other ways. A.

539.537

9686. Spall effects produced by a cylindrical and a spherical charge of high explosive. W. A. ALLEN AND W. GOLDSMITH. Letter in *J. appl. Phys.*, **25**, 813–14 (*June*, 1954).

Experiments are described of the spall effects produced by the explosion of a cylindrical or spherical charge in contact with a steel plate. The conclusions

stated are that spalling is associated with a spherically divergent stress wave and that, as regards spall effects near the surface, the more complicated cylindrical charge geometry can be replaced both experimentally and theoretically by that of the spherical charge.

H. J. H. STARKS

539.576

9687. The hardness properties of cube faces of diamond. E. M. WILKS AND J. WILKS. *Phil. Mag.*, **45**, 844–50 (*Aug.*, 1954).

Experiments have been made on the abrasion hardness properties of polished cube faces of diamond in directions parallel to the crystallographic axes. Provided the faces coincide with the lattice planes, a fourfold symmetry of hardness is observed. However, a misorientation of the face with respect to the lattice of more than 30 min produces an asymmetry in the hardness values. This may well explain why diamond polishers have seldom found the fourfold symmetry on cube planes, for it is very difficult to grind a face on a substance as hard as diamond to within a few minutes. A.

539.67

9688. Temperature variation in internal friction of polymers (PMA). E. JENCKEL AND K.-H. ILLERS. *Z. Naturforsch.*, **9a**, 440–50 (*May*, 1954) *In German.*

Using a torsion pendulum, measurements were made at a constant frequency of 0·5 c/s and at temperatures in the range − 60 to + 90°c of the log. dec. of PMA, with and without additional diluting agents (mostly butyl acetate and chloroform). Curves are given which show the marked variation in decrement as the temperature is changed. A Maxwell model is derived to account satisfactorily for the results observed. The relaxation times and activation energy of the various compositions are discussed.

H. J. H. STARKS

539.89

9689. Compressibilities of crystalline and glassy modifications of selenium and glucose. C. E. WEIR. *J. Res. Nat. Bur. Stand.*, **52**, 247–9 (*May*, 1954).

Data are reported for the compression of selenium and α-glucose in both glassy and crystalline modifications at 21°c between 1000 and 10 000 atm. The compressibilities of the glassy form were found to be considerably larger than those of the crystals. A transition of unknown origin was observed to occur in glassy glucose between 7000 and 8000 atm. A.

PHYSICAL CHEMISTRY 541

PHASE EQUILIBRIUM . CHEMICAL REACTIONS 541.11/.12

541.123.5

9690. The calculation of equilibrium constants for several exchange reactions of nitrogen-15 between oxycompounds of nitrogen. W. SPINDEL. Letter in *J. chem. Phys.*, **22**, 1271 (*July*, 1954).

In order to evaluate such equilibrium constants, fundamental vibrational frequencies of the molecules containing N^{15} were calculated from those of molecules containing N^{14}. The molecules chosen were NO, NO_2 (with central and with valence force field), NO_3^- and NO_2^-. The calculated frequencies and equilibrium constants are tabulated. A. J. TAYLOR

541.124

9691. The reaction of methyl radicals with aceto- and propio-nitrile. M. H. J. WIJNEN. *J. chem. Phys.*, **22**, 1074–6 (*June*, 1954).

The reaction of CD_3 radicals with aceto- and propionitrile has been studied over the temperature range 100 to 300°c at various intensities. The CD_3 radicals were produced by photodecomposition of acetone-d_6. As activation energies for the reactions $CD_3 + CH_3CN \rightarrow CD_3H + CH_2CN$ and $CD_3 + C_2H_5CN \rightarrow CD_3H + C_2H_4CN$, $E_2 = 10 \pm 0{\cdot}5$ kcal and $E_3 = 8{\cdot}5 \pm 0{\cdot}5$ kcal were obtained. A.

541.124

9692. Altered proportions of isotopes of molecular nitrogen as evidence for a monomolecular reaction. M. WALSER, J. GEORGE AND L. J. BODENLOS. Letter in *J. chem. Phys.*, **22**, 1146 (*June*, 1954).

In a reaction in which nitrogen gas is evolved from a compound containing two N atoms, the distribution of $N^{14}N^{14}$, $N^{14}N^{15}$, $N^{15}N^{15}$ molecules should be the same as that in which the isotopic atom-pairs occur in the parent compound, provided the reaction is monomolecular. In this way, by starting with urea containing a known proportion of N^{15} atoms and analysing the resultant nitrogen gas in a mass spectrometer, it has been shown that the reaction of hypobromite with urea is monomolecular. A. J. TAYLOR

541.124

9693. The modes of decomposition of *n*-pentane. III. Fate of ethane at low pressures. B. C. SPALL, F. J. STUBBS, C. J. DANBY AND C. HINSHELWOOD. *Proc. Roy. Soc. A*, **225**, 64–70 (*Aug.* 6, 1954).

For Pt II, see Abstr. 6954 (1954).

541.124 : 536.75

9694. The production of entropy in chemical reactions. A. E. NIELSEN. *Bull. Acad. Roy. Belgique Cl. Sci.*, **40**, *No.* 5, 539–43 (1954) *In French.*

For chemical reactions $A_1 + A_2 = B_1 + B_2$, the mechanisms considered are: $A_1 = B_2 + X$, $X + A_2 = B_1$ and $A_1 + X_1 = X_2 + B_2$, $A_2 + X_2 = X_1 + B_1$. Prigogine's theory of minimum entropy is studied for these examples for the system not in or near equilibrium. C. TURNER

541.124 : 539.132

The activation energy of the H + H_2 reaction. *See Abstr.* 9469

541.124 : 539.155.2

9695. The effect of ring substituents on the isotope effects in reactions of carbonyl-C^{14} esters and ketones. G. A. ROPP AND V. F. RAAEN. *J. chem. Phys.*, **22**, 1223–7 (*July*, 1954).

The variations of the isotope fractionation factor k_{14}/k_{12} with changes in ring substituents, reaction

temperature, solvent, concentration, and the alcohol group have been studied for the saponification of ethyl benzoates (α-carbon-14). The variations of the k_{14}/k_{12} ratio with changes in temperature and ring substituents have been studied for the formation of the 2,4-dinitrophenylhydrazones of acetophenones (α-carbon-14). A.

541.127

9696. A treatment of chemical kinetics with special applicability to diffusion controlled reactions. R. M. NOYES. *J. chem. Phys.*, **22**, 1349–59 (*Aug.*, 1954).

If a molecule is produced in a medium containing molecules able to react with it, its instantaneous reactivity is a function of the time since its formation. At very short times the reactivity is determined by the conventional "true" rate constant k, which is the product of the rate constant for encounters and the probability of reaction during an encounter. At long times (10^{-9} sec or greater in many liquids), the reactivity falls to a value determined by the "long-time" rate constant k'. The constants k and k' differ by the factor $1 - \beta'$, where β' is the probability that a specific pair of molecules separating from a non-reactive encounter will ultimately react with each other. If β' is small either because there is little chance of reaction per encounter (activation control), or because there is little chance the specific pair will undergo a subsequent encounter (as in gas phase), the two rate constants are virtually identical and conventional kinetics apply. Equations are developed for the time dependence of the reactivity of a molecule in such a system, and a model is suggested for evaluating the necessary parameters in terms of the relative diffusion coefficient, the encounter diameter, and the root-mean-square displacement distance during diffusion. Application of available kinetic data indicates that diffusive displacements in liquids are of the order of a molecular diameter and take place with a frequency of the order of 10^{11} sec^{-1}. In the quenching of fluorescence and other processes where reactive molecules are produced singly, experimental measurements have given the "long-time" rate constant, k'. When reactive molecules are produced in pairs, the recombination process in a thermal equilibrium is described by the "true" rate constant, k; but k' has been obtained from all rate measurements on the recombination of pairs produced photochemically. Experiments are suggested for obtaining information on systems during the short time in which the apparent rate constant is changing. A.

541.127 : 539

9697. The factors affecting reaction kinetics in the solid state. J. BÉNARD. *Cahiers de Phys.*, *No.* 49, 23–43 (*May*, 1954) *In French.*

Lecture delivered at a conference on wave-mechanics and chemical kinetics in May 1953.

541.127 : 541.123.5

9698. On the kinetics of the exchange processes in ion exchangers. L. W. HOLM. Letter in *J. chem. Phys.*, **22**, 1132–3 (*June*, 1954).

The rate-determining process in the exchange of ions A in solution with ions B in the resin is considered to be the diffusion of A and B either inside the resin or in the solution. By using radioactive tracer technique the rate of exchange of Na^+ between Na^+-saturated Dowex 50 and 0·01 M NaCl solution is shown to be determined by diffusion in the liquid, that of Sm^{3+} between Sm^{3+}-saturated Dowex 50 and 0·045 M $Sm(NO_3)_3$ solution by diffusion in the resin. W. GOOD

541.127.2

9699. Law of mass action and the formation of imperfect [unstable] complexes. A. MASSOULIER. *J. Phys. Radium*, **15**, 13 S–16 S (*April*, 1954) *In French.*

An attempt at determining the quantity of the complex of the K_2CdI_4 type by using the principles of the law of mass action, based on the method of P. Job [*Annales de Chimie*, **9**, 135 (1928)], according to which the value ξ ($= x/\Gamma$, Γ being the molecular concentration, equal for either reactant) in the equation $(y - m\xi)^m(1 - y - n\xi)^n = K'\xi$ passes through a unique maximum for $y = y_M$ given by the relationship $y_M/m = (1 - yM)/n$. Several applications of Job's method to the spectral absorption by solutions containing the complexes are discussed. When the method is applied to spectrophotometric measurements conducted on equimolecular solutions (Γ varying from 5/4 to 1/500) of KI and CdI_2, it is found that the equation $Cd^{2+} + 4I^- \rightarrow CdI_4^{2-}$ does not represent exactly the formation of the complex. F. LACHMAN

ELECTROCHEMISTRY 541.13

541.13 : 536.7

9700. Free-energy change in the transfer of H^+ ion from ethanol to water. L. M. MUKHERJEE. *Naturwissenschaften*, **41**, *No.* 10, 228–9 (1954).

This is calculated using the Born equation [*Z. Phys.*, **1**, *No.* 1, 45–8 (1920)] and compared with the value obtained from measurements of the e.m.f. of the cell

$$\overline{Pt}, H_2; HCl_{H_2O}; \overbrace{Ag/AgCl}\ Ag/AgCl; HCl_{EtOH}; H_2, \overline{Pt}$$

and extrapolation to infinite dilution for both sides of the combination. Good agreement is found. W. GOOD

541.13 : 541.11/.12

9701. Conductivity of supercritical solutions of sodium chloride and water. J. T. CORWIN AND G. E. OWEN. Letter in *J. chem. Phys.*, **22**, 1257 (*July*, 1954).

Dilute solutions of NaCl in water between 375 and 400°C show two phases, one, liquid-like, which has a conductivity little affected by changes in pressure and the other which has a conductivity greatly affected by changes in pressure. The bearing of these results on those of Fogo *et al.* [Abstr. 5071 (1954)] is discussed. W. GOOD

541.132 : 532.77

The application of the Debye–Hückel theory to polyions. I. The range of applicability of the Debye limiting law. *See Abstr.* 8970

541.133 : 535.566.2

Polarimetric and electric study of aqueous solutions of tartaric and boric acids. *See Abstr.* 9153

541.133.08

9702. The direct current method of electrolytic conductance measurement. D. J. G. Ives and S. Swaroopa. *Trans Faraday Soc.*, **49**, 788–91 (*July*, 1953).

A modified direct current method of measuring electrolytic conductance is described. It has the advantage that it permits the use of a variety of reversible electrodes without the restrictions of small size and accurate location within the conductance cell. It is suggested that this simplifies and widens the scope of the direct current method, and this conclusion is supported by measurements carried out with a number of standard electrolytes. A.

541.135

9703. The role of the hydration configuration in electronic processes involving ions in aqueous solution. R. Platzman and J. Franck. *Z. Phys.*, **138**, *No.* 3–4, 411–31 (1954).

The nature of small ions in electrolytic (e.g. aqueous) solutions is discussed in terms of the configuration of the adjoining polarized medium, and the rôle of this configuration in electronic transitions involving one or a pair of ions is treated in a general way. Light absorption by a single ion is shown to depend critically on this configuration; a theory developed previously by the authors is reviewed, and future possibilities of exploring the nature of the configuration by investigation of such spectra are explained. Electronic transitions, such as an "electron transfer" process, during binary collisions of ions are treated, and a general method is developed, based upon Debye's "diffusion" theory for ion collision rates and a non-adiabatic type of potential curve. Rates of chemical processes are found to depend decisively on the interaction of two ions at separations where the simple Coulomb law is not valid. A.

541.135.5

9704. Behaviour of surface active substances at the dropping mercury electrode at different frequencies of the applied field. S. L. Gupta. *Proc. Indian Acad. Sci. A*, **39**, 282–9 (*June*, 1954).

Increase in frequency is found to lower the depression effect of the adsorption films of surface active substances on the dropping mercury electrode capacity. This fact appears to be of great interest from the point of view of elucidating the factors controlling the condenser current. Increase in frequency decreases the desorption peaks which points at the existence of some slow processes controlling the passage of electric charges during the sorption and desorption cycles. A.

541.135.5

9705. Exact solution of the Debye–Hückel equations for a polarized electrode. J. R. Macdonald and M. K. Brachman. *J. chem. Phys.*, **22**, 1314–16 (*Aug.*, 1954).

A recent solution of the Debye–Hückel equations for a single polarized electrode obtained by Breyer and Gutmann is revised to yield an exact solution of this problem. This solution is compared with an earlier result of H. Müller derived from different initial equations and the solutions are shown to be identical. The present solution applies only to the diffuse part of the double layer of electrolyte theory and yields the following expression for the mean local potential within the material as a function of the distance x from a polarized anode

$$\psi = (2kT/e)\ln\left[\coth\left\{\tfrac{1}{2}(x/L_D + \sinh^{-1}[\operatorname{csch}(eV_0/2kT)])\right\}\right],$$

where L_D is the Debye length and V_0 the potential applied between electrode and charge-containing material. A.

541.135.5 : 537.222

9706. Static space-charge effects in the diffuse double layer. J. R. Macdonald. *J. chem. Phys.*, **22**, 1317–22 (*Aug.*, 1954).

Exact solutions of the static Debye–Hückel space-charge equations for one and for two blocking electrodes are compared analytically and graphically. It is found that the simpler one-electrode solution may be employed to characterize the diffuse double-layer with high accuracy in most experimental situations in place of the less tractable two-electrode solution which involves Jacobian elliptic functions. Some consequences of the strong non-linear voltage dependence of the exact solutions are considered and the application of the solutions to physical situations is discussed. A.

541.138 : 537.525.8

9707. Chemical synthesis from free radicals produced in microwave fields. R. L. McCarthy. *J. chem. Phys.*, **22**, 1360–5 (*Aug.*, 1954).

Although much attention has been given to the physics of a microwave glow discharge, substantially less information is available regarding the chemical effects upon a gas undergoing such excitation. The chemical effects of a 2450 Mc/s glow discharge on several gases have been studied and quantitative measurements made on a few simple molecular systems, e.g. N_2, H_2, O_2, air, CH_4. A fundamental relationship has been found to exist between the yield in simple chemical systems and the controllable variables of electric field strength, contact time and pressure. Analytical expressions for these relationships have been obtained. A.

PHOTOCHEMISTRY . RADIATION CHEMISTRY 541.14/.15

541.14

9708. Oxidation and reduction of aqueous ferrous-ferric sulphate induced by visible light absorption of mercuric sulphide. L. I. Grossweiner and S. Gordon. Letter in *J. chem. Phys.*, **22**, 1139–40 (*June*, 1954).

A stirred suspension of (red) HgS powder in ferrous or ferric sulphate solutions 0·8 N with respect to H_2SO_4 was irradiated with visible light (Hg vapour lamp with Corning No. 3385 filter). Curves for air-saturated solutions are given showing amount of oxidation (in ferrous systems) and amount of reduction (in ferric systems) as a function of the radiation dose. NaCl is found to inhibit oxidation and enhance reduction. By using a series of filters it was established

that no reduction of ferric solutions takes place for wavelengths above 600 mμ which, it is pointed out, is close to the photoconductive cut-off of HgS crystals and to the wavelength where the reflectance of the powder shows an abrupt increase. Possible mechanisms for the reactions are suggested. W. GOOD

541.14

9709. Spectroscopic investigation of the photochemical stability of medicinal paraffin oils. R. SCHNURMANN. *J. Phys. Radium*, **15**, 503–7 (*June*, 1954) *In French.*

Between 2400 and 2800 Å, the absorption of stable paraffin oils changes considerably if they are irradiated by u.v. light through quartz. It is suggested that there is a group *A* of compounds which absorbs the u.v. and which changes the chemical composition of a group *B* of compounds. C. TURNER

541.14

9710. Quantum yield of para-diazo *N–N*, dimethylaniline zinc chloride dihydrate at 3660 Å. A. BARIL, JR. Letter in *J. chem. Phys.*, **22**, 1275–6 (*July*, 1954).

The absorption spectrum in the range 2200–6000 Å of the diazo compound was determined. There is strong absorption between 4200 Å and 3200 Å. The values obtained for the quantum yield vary between 0·950 and 0·988. W. GOOD

541.15

9711. Irradiation of chloroform–water systems with Co^{60} gamma-rays and betatron X rays. R. W. HUMMEL, A. B. VAN CLEAVE AND J. W. T. SPINKS. *Canad. J. Chem.*, **32**, 522–31 (*May*, 1954).

The production of acid from two commercial brands of chloroform, on exposure to Co^{60} γ-rays and high-energy X-rays from a betatron, has been measured. Inhibitor-free chloroform liberates acid in amounts varying linearly with the radiation dose. The specific yield, in micromoles of acid produced per litre of chloroform per kiloroentgen, varies inversely as the square root of the dose rate. The specific yields are slightly less for betatron radiations, compared with Co^{60} γ-rays. The average lifetime of the free radical chains is about one second. A.

541.15

9712. How radiation affects long-chain polymers. A. CHARLESBY. *Nucleonics*, **12**, 18–25 (*June*, 1954).

The effects of ionizing radiation on long-chain polymers of the thermoplastic type are surveyed. Changes in the melting, solubility and elastic properties due to chain-cross-linking in polyethylene and polystyrene and the vulcanizing of rubber by radiation are described. Effects resulting from chain-degradation in PTFE, polymethyl methacrylate and polyisobutylene, under irradiation, are also considered. Possible industrial applications are discussed.

L. R. SHEPHERD

541.15

9713. Changes in some physical properties of polyethylene by pile irradiation at 80°C. M. ROSS. *Atomic Energy Res. Establ.* [*Harwell*] *Rep. M/R* 1401, 7 + vi *pp. figs.* (1954).

Changes are studied in the density, percentage of crystallinity and Young's Modulus of polyethylene due to pile irradiation at about 80°C. It is shown that increasing the temperature during irradiation makes possible the production of amorphous material after a shorter irradiation time, and a wide variety of materials of varying density and different mechanical properties can be made. A new method of estimating the density of amorphous material in ordinary (unirradiated) polyethylene is outlined. A.

541.15

9714. Szilard–Chalmers reaction in crystalline compounds of chromium. G. HARBOTTLE. *J. chem. Phys.*, **22**, 1083–8 (*June*, 1954).

The Szilard–Chalmers reaction has been observed in a number of crystalline compounds of tri- and hexavalent chromium. The effect of neutron- and external γ-irradiation has also been investigated. It was found that in a series of alkali chromates and dichromates the retention varied from 50 to 90%, while ammonium chromate and dichromate were much lower. The results are interpreted in terms of hot-atom reactions of the recoil fragments in the crystal, and hydrolysis and reduction reactions taking place on dissolution of the crystals. A.

541.15

9715. The Szilard–Chalmers reaction in aqueous solutions of tri- and hexavalent chromium. L. M. FISHMAN AND G. HARBOTTLE. *J. chem. Phys.*, **22**, 1088–93 (*June*, 1954).

Szilard–Chalmers (nuclear recoil) reactions have been observed in aqueous solutions of tri- and hexavalent chromium. The effects of pH, concentration, and a number of other variables have been examined, and the retention is found to depend on several of these factors. The results are interpreted in terms of thermal oxidation-reduction and exchange reactions of chromium v and/or IV. A.

541.15

9716. Szilard–Chalmers reaction on CH_3I. T. BRUSTAD AND J. BAARLI. *J. chem. Phys.*, **22**, 1311–13 (*Aug.*, 1954).

Studies on the "hot atom" reactions resulting from slow neutron irradiation of methyl iodide have been carried out. The results show that concentration of free iodine below 0·007% in CH_3I during irradiation has a great influence on the distribution of the 25-min I^{128} between CH_3I, CH_2I_2 and I_2. Comparison of experiments at temperatures below −55°C with carefully purified CH_3I indicates that the yield of the reactions in pure CH_3I is: CH_3I, 44·4%; CH_2I_2, 11·2%; and I_2, 44·2%. The influence of the temperature on this reaction shows that no change in yield has been found at the shift between liquid and solid state. Co^{60} rays at a rate of 2 roentgen per min at the side of sampling during neutron irradiation, do not change the distribution of the radioactive I^{128} between the compounds. A.

541.15

9717. Chemical action of ionizing radiations: excitation of optical levels by particles of relatively low energy. J. WEISS. Letter in *Nature* [*London*] **174**, 78–9 (*July* 10, 1954).

Chemical effects produced by ionizing radiations or particles in aqueous solutions at energies greater than 7·5 eV will primarily be "indirect" since the water absorbs most of the energy. At energies below

7·5 eV, water is transparent, and excitation of optical levels of solutes may become important. Unlike that in the "indirect" effect, the yield in this "direct" effect is proportional to concentration. Assuming that production of one ion pair requires 33 eV, 3 electrons will be released for each 100 eV of absorbed energy, so that under optimal conditions there might be a yield of 3 additional excited solute molecules. Examples are discussed. C. B. ALLSOPP

541.15 : 548.7

9718. The kinetics of the coloration and luminescence of vitreous silica induced by irradiation with X- and γ-rays, with observations on related phenomena. F. S. DAINTON AND J. ROWBOTTOM. *Trans Faraday Soc.*, **50**, 480–93 (*May*, 1954).

Methods are described for determining the kinetics of (i) colour-centre formation induced in vitreous quartz by irradiation with X- and γ-rays, (ii) the optical bleaching of these centres and (iii) the slow radiophosphorescence. Observations on the X-ray induced fluorescence and the emission spectra of the radioluminescence are also recorded. The colour centres involved are, in some respects, similar to those in irradiated alkali halide crystals. The long-lived phosphorescence, however, appears to be impurity-activated. These results are discussed in the light of existing theories. A.

541.15 : 621.315.61 : 621.317.333

9719. Testing electrical insulation for use in gamma-ray fields. C. MANNAL. *Nucleonics*, **12**, 49–53 (*June*, 1954).

A silicone-resin-impregnated glass-mica tape, used as insulation in an electromagnetic Na-coolant pump in the SIR reactor, was tested for h.v. breakdown after large accumulated neutron- and γ-radiation doses. No significant reduction in breakdown voltage was found up to 10^{10} r. Abrasion tests showed that the mechanical properties of the insulation were not seriously affected after 30 days in a flux of 10^{12} $n/cm^2/sec$ and $0{\cdot}5\times10^{12}$ 1 MeV $\gamma/cm^2/sec$ at 160°–180°C, but after 60 days considerable deterioration was found. The results of analyses of gases evolved during the irradiation are given. L. R. SHEPHERD (R)

DISPERSIONS . COLLOIDS . ADSORPTION
541.18

541.18.053 : 534.312.9

Ultrasonic production of aerosols. *See Abstr.* 9017

541.182

9720. Short-range electrical forces between charged colloid particles. D. M. C. MACEWAN. Letter in *Nature* [*London*] **174**, 39–40 (*July* 3, 1954).

Theoretical. Calculations are made of the Stern layer (attractive) interaction potential (I) for two montmorillonite particles each with a "crystalline" layer of ions attached to it in a square lattice, for uni-, bi- and tervalent ions; I is compared with the van der Waals (attractive) potential (II) and with the Gouy layer (repulsive) potential (III). For $d < 30$ Å, I > II, but for $d = 30$ to 45 Å, I rapidly becomes unimportant compared with II; at $d = 20$ to 25 Å, III is comparable with I and rapidly outbalances it as d increases. With divalent ions, e.g. Ca, d does not exceed 20 Å (d = interlamellar spacing). [See also Abstr. 5059 (1949)]. S. J. GREGG

541.182.5 : 539.32

Elastic constants of gels. *See Abstr.* 9677

541.183

9721. Stresses and strains in adsorbent–adsorbate systems. E. A. FLOOD AND R. D. HEYDING. *Canad. J. Chem.*, **32**, 660–82 (*July*, 1954).

From thermodynamic considerations a simple equation is derived which correlates length changes of a porous rigid adsorbent with its elastic and adsorptive properties. The equation contains a structure factor which is a constant characteristic of the adsorbent. Calculated and observed results agree reasonably well and suggest that, in the cases concerned, the assumptions underlying the derivation of the equation are valid. The underlying assumptions are: (*a*) both adsorbate and adsorbent can each exist separately in equilibrium with externally applied forces in states that are thermodynamically identical with their states in the adsorbate–adsorbent system, (*b*) adsorption isotherms represent paths of thermodynamic reversibility. A.

541.183 : 533.7

9722. A density method for [determination of] the accommodation coefficients of translation of gas molecules. J. W. HIBY, K. G. MÜLLER AND M. PAHL. *Z. Naturforsch.*, **9a**, 547–51 (*June*, 1954) *In German.*

The principle, and practical details, are given for a method for determination of the partial accommodation coefficient α_{trans} of the kinetic energy of the molecules of a gas at a solid surface. It depends on the alteration $\Delta\rho$ in density which occurs when the molecules are reflected, with a change in their temperature, from a surface (I) small in area compared with that of the walls of the vessel; $\Delta\rho$ is measured with a special ionization manometer whose plate serves as I. For N_2 on a gas-covered Ni surface the value $\alpha = 0{\cdot}86 \pm 0{\cdot}1$ has been obtained. Certain improvements are outlined. S. J. GREGG

541.183 : 537.226.2

9723. The dielectric behavior of sorbed water on silica gel. S. KUROSAKI. *J. phys. Chem.*, **58**, 320–4 (*April*, 1954).

For the purpose of clarifying the state of sorbed water on silica gel, the sorption isotherms of water vapour on silica gel were obtained to determine the differential heat of sorption, as well as to measure the changes in the apparent dielectric constant of silica gel powder caused by an increase in water content and to calculate the specific polarization of the sorbed water. The apparent loss factor of silica gel having different moisture contents was also measured in the frequency range of 2 kc/s–1 Mc/s. As a result, it has been ascertained that three different states exist for sorbed water on silica gel. In the first sorption stage (water content <15 mg/g), the sorbed water indicates a very low specific polarization; it is firmly bound to the silica gel surface, and has a high heat of sorption. In the second sorption stage (15–94 mg/g), the sorbed water is assumed to be in the condition similar to that of water dissolved in organic solvents. Sorbed water

in the third sorption stage (>94 mg/g), generally present in trimolecular layers or more, is considered as capillary condensed water, showing a maximum loss factor in the vicinity of 10 kc/s. The ε''_{max} value can be explained semi-quantitatively by the theory of binary aggregates, and it is surmised that capillary condensed water on silica gel has a much more strongly developed hydrogen bonding (approaching that of ice) than liquid water. A.

541.183 : 539.16.08

9724. Studies on ionized surface layers using α-recoil atoms. The coadsorption of Bi-212 ions at sodium dodecylsulfate surface layers. N. H. STEIGER AND G. ANIANSSON. *J. phys. Chem.*, **58**, 228–35 (*March*, 1954).

A new radioactive method for measuring the adsorption of solutes at the surface of a solution has been developed. Utilizing the α-recoil mechanism the co-adsorption of Bi^{212} ions at the surface layer of aqueous solutions containing nitric acid (10^{-1}–10^{-4} M) and sodium dodecylsulphate in various concentrations has been studied. Upon the α-decay of Bi^{212} the β- and γ-active Tl^{208} atoms recoiled from the surface of the solutions and were collected on a negatively charged metal plate placed over the solutions. When the activity of the recoil atoms on the plate had reached saturation the plate was removed and its activity followed with a G.M. counter, thus giving a relative measure of the co-adsorption of the Bi ions. The range of the recoiling Tl^{208} atoms in water is about 1000 Å and should thus be of suitable magnitude for the investigation of surface layers. The surface tension of the solutions as well as the amounts of radiocolloidal Bi^{212} and Pb^{212} in the solutions were determined. Optimum conditions for the above mentioned method are obtained in solutions containing 0·1–0·5 m mole of sodium dodecylsulphate/l and 10^{-2}–10^{-3} mole of HNO_3/l. In these concentration intervals relatively high recoil activities, resulting in good precision, are obtained and further the amount of radiocolloids is not important. The ratio of polyvalent ions such as Pb^{212}, Pb^{208}, Bi^{212}, etc., to dodecylsulphate ions in the surface layer was estimated to be less than 1 : 100. The co-adsorption of polyvalent ions should thus not change the general character of the surface layer to any important extent. A.

541.185 : 539.4

The influence of adsorbed gases on the mechanical strength of metallic wires. *See Abstr.* 9680

CHEMICAL STRUCTURE 541.2/.6

541.24 : 535.434

9725. An apparatus for the determination of molecular weights by light scattering. L. HARVEY AND D. CLEVERDON. *J. sci. Instrum.*, **31**, 274–9 (*Aug.*, 1954).

The intensity of the light scattered by solutions of large molecules is frequently used as a measure of their weight-average molecular weight. The principles underlying the design of an instrument, and the detailed method of construction, are given. The cell for holding the liquid under examination differs entirely in design from those currently employed elsewhere. The measured signal from a solution is virtually free from extraneous light. This is due to the internal light absorption characteristics of the cell and to the careful positioning of the centre of observation. The principles of this cell design called for a number of mechanical and optical features unlike those encountered in conventional light-scattering apparatus. A.

541.51 : 539.132

The molecular orbital theory of chemical valency. *See Abstr.* 9482–3

541.553 : 539.153.4

Note on the theory of directed valence. *See Abstr.* 9529

541.62 : 539.132

9726. The energy difference of the two rotational isomers of 1, 2-dichloroethane in various solutions. A. WADA AND Y. MORINO. Letter in *J. chem. Phys.*, **22**, 1276–7 (*July*, 1954).

In order to confirm previous theoretical calculations [Abstr. 5093 (1954)] this energy difference was measured at various mixing ratios of the two isomers in several solvents with different dielectric constants. The energy difference was found from the intensity ratio of Raman lines. The differences found are plotted against the dielectric constants of the solvents. There is good agreement with the theoretical curve except for benzene and acetone. A. J. TAYLOR

541.621 : 535.343–15

9727. Spectroscopic study of an isomer of hydrogen peroxide. P. A. GIGUÈRE AND E. A. SECCO. *J. Phys. Radium*, **15**, 508–10 (*June*, 1954) *In French.*

Dissociated water vapour at low pressure condensed at liquid air temperature in an electric discharge shows a vitreous deposit in which is assumed an isomer of hydrogen peroxide H_2O–O. The infrared spectrum shows extra bands, not belonging to H_2O or H_2O_2. The strongest band is at 1305 cm^{-1}. This is not due to an O–O vibration. C. TURNER

LABORATORY APPARATUS 542.1/.7

542.4

9728. The firing of pyrophyllite for minimum distortion. V. E. DYKE. Letter in *Brit. J. appl. Phys.*, **5**, 270 (*July*, 1954).

Pre-baking of pyrophyllite at 750°c followed by slow cooling, before machining to size and final firing at 1050°c, reduces the dimensional changes and distortions to 0·08 ± 0·08%, about twenty times less than without pre-baking. W. M. LOMER

542.41

9729. A laboratory arc-melting furnace. M. L. NIELSEN AND I. B. JOHNS. *Rev. sci. Instrum.*, **25**, 596–8 (*June*, 1954).

Using a glass resin kettle as enclosure, and an inverted-*J* electrode, a small arc-melting furnace was designed for conveniently melting metals under an inert atmosphere. A.

CHEMICAL PROCESSES 542.9

542.952.6

9730. The effect of chain transfer on the distribution of molecular weights in high polymers. I. Combination. S. R. Palit and K. C. Majumdar. *Indian J. Phys.*, **28**, *Supplement* (*March*, 1954) = *Proc. Indian Assoc. Cultiv. Sci.*, **37**, 1–18 (1954).

An equation for the distribution of molecular weight taking into consideration all types of chain transfer, viz. by monomer, by solvent and by initiator is theoretically deduced. Besides giving a quantitative measure of the effect of a change in any of the factors involved in polymerization, which is also shown graphically, this equation leads to a number of interesting conclusions which are amenable to a direct experimental test. They are: (i) If a monomer is polymerized in presence of gradually increasing quantities of a solvent or a catalyst, and if r_0, $\bar{P}_n$ and $\bar{P}_w$ are the most probable D.P., number average D.P. and weight average D.P. respectively, all the above quantities diminish continuously but they satisfy the relation $\bar{P}_w > r_0 \geqslant \bar{P}_n$. (ii) The value of $\bar{P}_w/\bar{P}_n$ goes on increasing under similar circumstances from the lowest possible value of 1·5 to its upper limiting value of 2. (iii) The variation of $r_0/\bar{P}_n$ as well as of $\bar{P}_w/\bar{P}_n$ with respect to any of the factors, viz. nature of monomer, nature and quantity of solvent and temperature can be represented by a universal equation and hence by the same graph, provided the variations are represented in terms of $\bar{P}_n^0/\bar{P}_n$, where $\bar{P}_n^0$ is the D.P. of the hypothetical bulk polymerization without monomer transfer. (iv) The reciprocal of the interquartile distance of the distribution curve, $1/\Delta r$ (where $\Delta r = r_2 - r_1$, r_2 and r_1 being the maximum D.P. which cover three-fourths and a quarter of the total weight of the polymer respectively) is a linear function of $C_S(S/M)$ or $C_I(I/M)$ with a slope approximately equal to 0·5. A.

CHEMICAL ANALYSIS 543/545

544.61 : 535.247.4

A contribution to the development and understanding of flame photometry. *See Abstr.* 9035

545.822 : 539.155.2

9731. Optical spectroscopic determination of hydrogen isotopes in aqueous mixtures. H. P. Broida, H. J. Morowitz and M. Selgin. *J. Res. Nat. Bur. Stand.*, **52**, 293–301 (*June*, 1954).

Extension of the optical spectroscopic method of isotope analysis of gaseous mixtures of hydrogen and deuterium to mixtures of water and heavy water provides a direct method for determining the total water content of materials. A determination can be made on a sample of less than 0·1 cm³ in less than 10 min to an accuracy of a few per cent. Using a sample of at least 1 cm³, an accuracy of the order of 0·1% is obtained in an hour or less. This paper describes the system and the investigation of optimum operating conditions and effect of variations in operating conditions on precision and accuracy of measurement, as well as limitations of the technique. A sample of blood or serum can be measured directly almost as easily as one of distilled water. The optical spectroscopic method can be used to determine the water content of most materials, whether in the solid, liquid or gas phase. A.

CRYSTALLOGRAPHY 548

548.0 : 531.743

9732. A two-circle optical goniometer, specially adapted to measuring small crystals of organic compounds. W. G. Perdok and P. Terpstra. *Recueil Trav. chim. Pays-Bas*, **73**, 385–92 (*June*, 1954).

548.24

9733. On the glide twinning in single crystals of tin. H. Kihô and K. Ishii. *Mem. Coll. Sci. Univ. Kyoto A*, **27**, 23–30 (*April*, 1953).

By measuring the energy and the critical shearing stress simultaneously, the mechanism of glide twinning in single crystals of tin has been investigated experimentally by the use of a method first devised by Chalmers and somewhat improved by the present writers. The results obtained varied from specimen to specimen, ranging from $0{\cdot}9\times10^6$ to $4{\cdot}4\times10^6$ ergs/cm³ for the energy and from 23 to 61 kg/cm² for the critical shearing stress. Plotting the energy against the critical shearing stress, it has been found that there holds a relation $E = \frac{1}{2}eS$, where E is the energy for twinning per unit volume, e the magnitude of shear (being 0·12 in this experiment), and S the critical shearing stress for twinning. A.

548.5

9734. Report on precipitation. H. K. Hardy and T. J. Teal. *Progress in metal physics, Volume 5*, 143–278 (1954) [see Abstr. 9871 (1954)].

A comprehensive review discussing the following topics: Thermodynamics of precipitation (free-energy considerations, nucleation, fluctuation, metastable solid solutions, properties of precipitate particles), kinetics of precipitation (transformation rates, temperature dependence), precipitation and structure sensitiveness, structural changes accompanying precipitation (X-ray diffraction studies, methods and interpretation of results for Al–Cu, Al–Ag, Al–Mg–Si and other Al alloys, Cu–Be, Fe–C, Fe–N, magnetic hardening alloys), property changes (internal energy, magnetic properties, ageing curves, reversion, i.e. the loss of hardness or other properties produced by heating for very short times to temperatures above

the ageing temperature, property changes as evidence of the precipitation rates). 350 references.

E. P. WOHLFARTH

548.5

9735. Solidification of metals. U. M. MARTIUS. *Progress in metal physics, Volume* 5, 279–309 (1954) [see Abstr. 9871 (1954)].

A review discussing the following topics: Basic considerations of the process, i.e. the growth of an existing crystal nucleus into its own melt, early theories, experimental facts (ingots, single crystal growth, dendrites, substructures and impurities), interpretation of experimental facts. 55 references.

E. P. WOHLFARTH

548.5

9736. The formation of trigons on diamonds. A. HALPERIN. *Proc. Phys. Soc.* [*London*] *B*, **67**, 538–45 (*July*, 1954).

The results of observations on trigons on octahedral faces of diamonds are given. Imperfect steps are believed to be present on the growing surfaces and to cause the trigons to be formed. These steps are assumed to be formed as a result of accumulation of interstitial faults in the lattice. Further, it is shown that trigons are formed mainly below a certain temperature, characteristic to the growing face and to the imperfect steps on it. This temperature should be lower than the transition temperature for the same face on a perfect crystal, and seems to be thus reduced to temperatures at which the crystals might have been grown. The theory accounts for the observed characteristics of the trigons. A.

548.522

9737. Heterogeneous nucleation of crystals from vapor. G. M. POUND, M. T. SIMNAD AND L. YANG. *J. chem. Phys.*, **22**, 1215–19 (*July*, 1954).

A rate equation is derived for heterogeneous nucleation of crystals from the vapour on the basis of an adsorption, surface diffusion and statistical fluctuation mechanism. It is shown that this mechanism results in a rate at least 10^2 to 10^3 times greater than that calculated on the basis of direct addition of atoms to the critical nucleus from the vapour phase. The equation describes the temperature dependence of existing critical supersaturation data for heterogeneous nucleation. Analysis of the existing data by this treatment permits an evaluation of the standard free energy of adsorption. Particular attention is given to heterogeneous nucleation from atomic beams. A.

548.522 : 536.422.5

9738. Ice crystals formed spontaneously by the rapid expansion of moist air. V. J. SCHAEFER. *J. Colloid Sci.*, **9**, 175–81 (*April*, 1954).

548.538

9739. Oriented overgrowths of alkali halides on mica. N. D. LISGARTEN. *Trans Faraday Soc.*, **50**, 684–90 (*July*, 1954).

Microscopic studies have been made of the oriented overgrowth of alkali and ammonium halides on mica. The crystals were grown from solution. The range of orientation was found to extend beyond the limits given by Royer. A new feature is the occurrence of square-based orientations which are particularly evident in the range from potassium bromide to sodium chloride. A.

548.574

9740. The etching of diamond. I. Octahedron faces. M. OMAR, N. S. PANDYA AND S. TOLANSKY. *Proc. Roy. Soc. A*, **225**, 33–40 (*Aug.* 6, 1954).

The evolution of etch phenomena on (111) natural octahedron faces of a number of good-quality diamonds, produced by immersion in hot potassium nitrate in temperatures ranging from 500 to 700°C, was studied optically. The techniques employed were high-resolution microscopy under a variety of illumination conditions, multiple-beam interferometry and light-profile microscopy. Although the etching mechanism is continuous it is conveniently divided into three stages. It is established that the first stage begins with a preferential attack on any existing surface flaws and then develops into a random distribution of a large number of small etch-pits. The distribution of these is random, but the concentration of etch-pits is less within any growth trigons than elsewhere, and it is presumed that this is because of a lower concentration of dislocations within the trigons. In the second stage, a relatively small number of etch-pits grows steadily and these devour their smaller neighbours. The corners become rounded and flat-bottomed pits are frequent. An explanation is proposed. In this stage any growth trigons tend to become hexagonal in outline, and the mechanism for this is unfolded and described. The third stage occurs when the whole of the original face has been eaten away. It is characterized by spread and deepening of the pits such that at first they become triangular pyramid depressions and then ultimately a striking block formation results. It is established by optical measurement that the pile of blocks have plane sides which are mainly (221) (212) (122) faces and as etch develops less prominent (331) (313) (133) faces develop. Ultimately, these tend to become (334), etc. but then rounding sets in and the crystallographic faces tend to lose their character. A.

548.574

9741. The etching of diamond. II. Cleavage, dodecahedron and cube faces. N. S. PANDYA AND S. TOLANSKY. *Proc. Roy. Soc. A*, **225**, 40–8 (*Aug.* 6, 1954).

The etching of cleavage (111), dodecahedron (110) and cube (100) faces of three different diamonds was studied optically as in Pt I. In accordance with crystallographic expectation the etch-pits observed are triangular for (111), boat-shaped for (110) and square for (100). The evolution, distribution and shapes of the pits are discussed. Some depths are evaluated by interferometry and by the light-profile. A new feature which has emerged in each case is the appearance of a strongly marked rectilinear pattern proving each of the three diamonds to have a laminated structure. The (111) face is crossed with lines parallel to (111) edges, the (110) face is filled by a beautifully regular set of concentric hexagons with the sides parallel to (111) edges, and the cube face reveals an equally striking set of concentric rectangles, filling most of the face. These patterns consist of straight

slightly raised, ridges and are regions less susceptible to etch attack than the surrounding areas. Their profiles are demonstrated optically. The pattern offers clear evidence that in each crystal, growth has proceeded by layer formation leading to a strongly laminated fine structure. The etch-patterns reveal for the first time a sectional history of the growth of the diamond. The observations can be accounted for by postulating increased resistance to etching at the onset (or end) of each layer. The proposed growth by sheet layers is in conformity with the failure to find growth spirals from the examination of some hundreds of octahedron diamond faces. A.

MOLECULAR AND X-RAY CRYSTALLOGRAPHY 548.7

548.7

9742. Further calculations on the nuclear resonance spectrum of Al^{27} in spodumene. G. M. Volkoff and G. Lamarche. *Canad. J. Phys.*, **32**, 493–7 (*Aug.*, 1954).

Calculations of the expected dependence of the relative intensities of nuclear quadrupole resonance lines of Al^{27} on the orientation of a single crystal of spodumene with respect to a linearly polarized resonant magnetic field H_1 show that a suitably oriented single crystal should give rise to lines which are approximately twice as strong as those in a randomly oriented polycrystalline sample. The dependence of the matrix elements, which determine expected nuclear magnetic resonance line intensities, on the strength of a uniform external magnetic field H_0 is also given for one particular crystal orientation with respect to both H_0 and a linearly polarized field H_1. A.

548.7

9743. Periodic impurities in a periodic lattice. E. H. Kerner. *Phys. Rev.*, **95**, 687–9 (*Aug.* 1, 1954).

Because binary δ-function lattices of the Kronig–Penney type which have been previously studied are incapable of describing several important features of real crystals, the eigenvalue problem for a periodic linear chain $\ldots A(BB\ldots BB)A(BB\ldots BB)\ldots$ of arbitrary square-well, A and B atoms of an arbitrary concentration is taken up and solved. The methods used are generalizable to other binary or multi-nary chains. It is shown that a theorem of Saxon and Hutner and of Luttinger relating to the preservation of the common forbidden energies of pure A and pure B lattices in a mixed A, B lattice is peculiar to their δ-function representations of A and B, and is without general validity. A.

548.7 : 538.221

9744. Some remarks on the quantum theory of energy anisotropy of ferromagnetic crystals. L. Pal. *Acta. phys. Hungar.*, **3**, *No.* 3–4, 287–302 (1954) *In Russian.*

The quantum theory of the anisotropic part of the free energy of ferromagnetic crystals is treated. Replacing the spin-orbit interaction by an equivalent interaction of multipole character, for simple cubic and hexagonal crystals the anisotropic part of the free energy is determined from the spectrum of the energy corresponding to the quasi-saturated state of the ferromagnetic crystal at low temperature. For the dependence of anisotropy on temperature the following expression, independent of the crystal structure, is obtained: $K(T) = K_0\{1 - T^{3/2}(k_1T + k_0)\}$ where T denotes the temperature calculated from absolute zero while k_0, k_1 and K_0 are constants. The theoretical results agree fairly well with the experiment. A.

548.7

9745. The theory of elasticity and of wave-propagation in crystals from the atomistic standpoint. K. S. Viswanathan. *Proc. Indian Acad. Sci. A*, **39**, 196–213 (*April*, 1954).

The static method of obtaining the strain energy function of a crystal has been developed for the case where the potential energy of the entire lattice is a general quadratic in the nuclear displacements of the atoms of the crystal. It is shown that for heterogeneous strains, the deformation energy of the crystal is a quadratic in all the nine strain components. Starting from the most general expression for the strain energy function which is a quadratic in all the nine strain components and by assuming that the strain components are all linearly independent functions of the position vector of any point of the solid, the wave equations of Begbie and Born have been derived by means of Hamilton's variational principle. But these equations are not reducible to the symmetric form of the wave equations of the elasticity theory without further assumption of additional relations among the force constants. Since there is no justification for such new relations which restrict the generality of the force scheme used, the expressions of Begbie–Born and of Kun Huang for the elastic constants of crystals are not valid in a general force scheme. The expressions for the elastic constants which follow the different theoretical procedures are derived for the case of diamond and are compared with the experimental results. Finally, a cubic equation whose roots determine the limiting group velocities of the long acoustic waves travelling in any direction of the crystal, has been derived; this replaces the expression for the velocities of the long acoustic waves given earlier [Abstr. 857–60 (1954)]. A.

548.7 : 536.631

9746. Frequency spectrum and specific heat of a face-centered cubic lattice. I. C. W. Garland and G. Jura. *J. chem. Phys.*, **22**, 1108–13 (*June*, 1954).

A Born–von Kármán treatment is carried out for a face-centred cubic lattice using the techniques developed by Montroll. The frequency spectrum of the normal modes of vibration has been calculated. From this distribution function C_v is obtained. A power series in $1/T$ has been developed for C_v at high temperatures. An asymptotic approximation is discussed for C_v at very low temperatures. Numerical results are presented for silver; these results are compared with those obtained by Leighton and with experimental data. A.

548.7 : 536.631

9747. Frequency spectrum and specific heat of a face-centered cubic lattice. II. Low temperature region. C. W. GARLAND AND G. JURA. *J. chem. Phys.*, **22**, 1114–17 (*June*, 1954).

From the Born–von Kármán treatment of a face-centred cubic lattice a simplified secular equation valid for low frequencies has been obtained. The frequency spectrum of low-frequency normal modes of vibration has been calculated using the root sampling technique of Blackman. From this distribution function a T^3 law is obtained for C_v at low temperatures. The effect on the low-temperature specific heat of including interactions with neighbours more remote than the next-nearest neighbours is discussed. Numerical results are presented for silver. A.

548.7

9748. Theory of superexchange interaction in MnO crystal. J. YAMASHITA. *J. Phys. Soc. Japan*, **9**, 339–45 (*May–June*, 1954).

The mechanism of the superexchange interaction of MnO crystal is investigated qualitatively taking into consideration the non-orthogonality of wave-functions. The energy expression is obtained for both spin states, that is, the perfect parallel spin arrangement and the ordered antiparallel spin arrangement, by the method of Heitler–London–Lowdin. As a result it is found that the energy of the ordered antiparallel spin arrangement may be lower than that of the perfect parallel spin arrangement mainly by the effect of the *S*-energy, which consists of several overlap-integrals. A.

548.7 : 539.11

9749. The rule of mutual exclusion. T. VENKATARAYUDU. Letter in *J. chem. Phys.*, **22**, 1269 (*July*, 1954).

In crystals, unlike molecules with a centre of inversion, infrared and Raman frequencies are not necessarily mutually exclusive, because the centre of symmetry is not unique. For fundamentals, the exclusive rule holds, as the symmetry is the same with respect to all centres of inversion. An example is given, the space group O_h^7 needed for complete discussion of diamond vibrations, for which a combination line is permitted in both spectra. J. HAWGOOD

548.7 : 539.164 : 537.542

9750. On the differential conductivity excitation of CdS crystals by α-particles. W. KOLB. *Ann. Phys.* [*Leipzig*] **14**, *No.* 6–8, 397–411 (1954) *In German.*

The dependence of the current pulse produced by α-particles on their residual range was measured on thin single-crystal CdS lamellae. At high field strengths, the pulse height is a measure of the number of charge carriers excited by one α-particle. The variation of differential conductivity excitation with residual range agrees qualitatively with the Bragg curve measured for air. The crystals did not exhibit any amplification, saturation occurs at high field strengths. An explanation is given of the dependence of pulse height at low field strengths on the side at which the particles enter the crystal. J. FRANKS

548.7

9751. Some effects of neutron irradiation of diamond. A. H. BENNY AND F. C. CHAMPION. Letter in *Nature* [*London*] **173**, 1087 (*June* 5, 1954).

Type 2 diamonds, irradiated by neutrons, show a reduction in response when used as counters, as well as a reduction in ultraviolet transmission and electrical resistance. The results are interpreted as arising from the formation of electron traps which differ, however, in some way from the intrinsic traps since some degree of recovery occurs on heating. J. THEWLIS

548.7

9752. Possible macroscopic effects of single lattice defects. J. ROTHSTEIN. *Phys. Rev.*, **95**, 370–1 (*July* 15, 1954).

A spiral dislocation with axis perpendicular to the lattice planes of a layer lattice converts the disconnected sheets to a connected helicoid. Crystal properties dependent on propagation effects and so strongly anisotropic in the layered crystal may approach isotropicity as intraplane parameters can now dominate interplane propagation. A single defect may thereby have a macroscopic effect on semiconduction and photoduction, magnetic susceptibility, specific heat and other properties. Substances in which such effects may exist are listed. A.

548.7

9753. Uniformly moving dislocations in anisotropic media. R. BULLOUGH AND B. A. BILBY. *Proc. Phys. Soc.* [*London*] *B*, **67**, 615–24 (*Aug.*, 1954).

Solutions which correspond to surface waves are given of the general dynamic equations of anisotropic elasticity when all displacements are independent of one co-ordinate. These solutions are used to discuss the uniform glissile motion of a long straight dislocation line of arbitrary Burgers vector by a generalization of a method previously used by Eshelby for the isotropic case. Although the method used here is generally applicable, explicit solutions are for simplicity given only when the moving dislocation line is so related to the symmetry elements of the crystal that the edge and screw components can be considered separately. The corresponding solutions for static dislocations in anisotropic media and uniformly moving dislocations in isotropic media can be derived from these solutions. The dislocation line is also treated in the Peierls–Nabarro approximation and expressions are derived for the variation with velocity of the widths of the edge and screw components. The results are illustrated by considering the variation with velocity of the widths of dislocations moving in the basal planes of magnesium, zinc and cadmium. A.

548.7 : 537.311.33

9754. Theory of dislocations in germanium. W. T. READ, JR. *Phil. Mag.*, **45**, 775–96 (*Aug.*, 1954).

Dislocations have a large effect on the electrical properties of germanium. Experiments show that dislocations act as acceptor centres. This paper discusses a simple model (due to W. Shockley) which identifies dislocation acceptors with the dangling unpaired electrons on the edge of the extra atomic plane of a dislocation having some edge component. In *n*-type germanium the line of acceptors along a dislocation accepts electrons and becomes negatively charged. The electrostatic energy in the resulting space-charge region is found and shown to be a dominant factor in determining the occupation of dislocation acceptors. Formulae are given for the temperature variation of the average electron

concentration in *n*-type material that has been lightly deformed by plastic bending. Experiments are suggested to test the theory and determine exactly the energy level of the dislocation acceptors. A.

548.7

9755. Colour centers in alkali halide crystals. II. F. SEITZ. *Rev. mod. Phys.*, **26**, 7–94 (*Jan.*, 1954).

After a summary of the earlier review [Abstr. 2317 (1947)] recent developments of theory and experiment are discussed. Topics include: (*a*) Studies of properties of uncoloured salts, electrolytic conductivity, influence of divalent ions, ionic mobilities, diffusion measurement, electron densities, excitons and migration of electrons and positive holes. (*b*) Additively coloured crystals; density changes on coloration, *F* centres, coagulation of centres, *F*-centre photoconductivity, luminescence, paramagnetic resonance and theoretical investigation of the *F*-centre configuration; crystals with excess halogen, studies of *V* centres. (*c*) Crystals coloured by X-rays at low temperature; coloration, bleaching, temperature stability of *V* bands, *M* bands, *V*-band photoconductivity. (*d*) Crystals coloured by X-rays at very low temperatures; *F*- and *V*-band properties, bleaching, centre formation processes, *H* centres. (*e*) Studies of photoelectric emission from coloured crystals. (*f*) Crystals containing foreign ion impurities.

G. F. J. GARLICK

548.7

9756. Theory of color centers. III. Continuum models of $F2^+$- and $F2$-centers. T. NAGAMIYA AND N. TATSUUMA. *J. Phys. Soc. Japan*, **9**, 307–10 (*May–June*, 1954).

For Pt II, see Abstr. 8561 (1952). $F2^+$- and $F2$-centres, the molecule ion and molecule formed from two *F*-centres, are treated by the variational method developed by R. Kubo The crystal is supposed to be a continuous medium with dielectric constants κ (static) and κ_0 (optical) and the two negative ion vacancies are considered as point charges. The polarization arising from ionic displacements is supposed to give a fixed field for the electronic motion. The electronic levels are calculated and compared with those obtained by Kubo for the *F*-centre. A rough estimate of the dissociation energies is also given. *A.*

548.7

9757. Theory of color centers. IV. Energy levels of various complex centers. T. NAGAMIYA, T. KOJIMA AND H. KONDOH. *J. Phys. Soc. Japan*, **9**, 310–15 (*May–June*, 1954).

Several complex centres consisting of two or more negative and positive ion vacancies with one or two electrons trapped there are treated by an approximate method of taking for the electronic wave-function a linear combination of the valence wave-functions of the positive ions which surround the vacancies. The resonance integral between two neighbouring positive ions is determined in the case of *F*-centre by comparing theory with experiment and then it is used for other centres. Rough estimates of the dissociation energy of each centre are also given. A.

548.7 : 537.312.5 : 538.632

A.C. Hall and magnetoresistive effects in photoconducting alkali halides. *See Abstr.* 9422

548.7 : 537.226.2

9758. Kinetic properties of the domains in Rochelle salt. T. MITSUI AND J. FURUICHI. Letter in *Phys. Rev.*, **95**, 558 (*July* 15, 1954).

The relation between the propagation velocity v of a ferroelectric domain wall and the electric field E is $\gamma v = 2P_s(E - E_0)$, where P_s is the saturation polarization [Abstr. 4481 (1953)]. Further study shows that the constants γ and E_0 are both structure-sensitive, and that $\gamma \propto P_s$ as the temperature changes. The relaxation time for the appearance of new domains on application of a field in the *a* direction is $\tau = \tau_0 \exp(C/E)$, τ_0 and C being constants. Nucleation of the domains appears to take place at imperfections.

J. HAWGOOD

548.7 : 537.226.2

9759. Domain formation and domain wall motions in ferroelectric $BaTiO_3$ single crystals. W. J. MERZ. *Phys. Rev.*, **95**, 690–8 (*Aug.* 1, 1954).

The nucleation and growth of ferroelectric domains in barium titanate have been studied as a function of applied electric field and temperature. The optical and electrical measurements were made on thin single-crystal plates normal to *c*, the polar direction. When the electric field applied along this direction is reversed, new domains with opposite polarization are formed. The manner of growth of these domains is very different from that of domain growth in ferromagnetic materials. The sidewise motion of the 180° side walls (walls between domains with antiparallel polarization) which is common in ferromagnetic crystals is almost never found in barium titanate. Instead its polarization is changed by the formation of very many new antiparallel domains which are extremely thin (10^{-4} cm) and appear to grow only in the forward direction. The explanation of this behaviour is found in the weak coupling between the dipoles perpendicular to the dipole direction. The wall thickness is small, of the order of one to a few lattice constants; the wall energy in $BaTiO_3$ is of the order of 10 erg/cm^2. Electrical pulsing experiments substantiate the optical observations very clearly. Pulsing the samples at different temperatures shows that the nucleation rate of new domains is accelerated at elevated temperatures. Furthermore, the growth of the new domains is faster at higher temperatures. Experimental results are presented showing how the switching current and the switching time depend on applied electrical field, on temperature, and on the size of the sample. A.

548.7

9760. Twinning and diffusionless transformations in metals. E. O. HALL. *London*: *Butterworths* (1954) ix + 181 *pp.*

Review in *Acta cryst.*, **7**, 524 (*July*, 1954).

548.7

9761. The crystalline state. III. The determination of crystal structures. H. LIPSON AND W. COCHRAN. *London: Bell and Sons* (1953) ix + 345 *pp.*

Review in *Acta cryst.*, **7**, 525–6 (*July*, 1954).

548.7 : 535.343.2

The spectrum of crystal ions. *See Abstr.* 9089

548.73/.74 : 539.26/.27

X-ray and electron investigation of materials. *See Abstr.* 9661–72

548.73/.74

9762. Line interaction in X-ray and electron diffraction photographs. D. M. C. MacEwan; G. D. Archard. Letters in *Brit. J. appl. Phys.*, **5**, 270 (*July*, 1954).

MacEwan points out a subjective factor omitted in Archard's work on the visual examination of X-ray and electron diffraction lines, which results in an apparent displacement of these lines to an extent depending on the line shape and proximity of other lines. Archard acknowledges this. J. THEWLIS

548.73

9763. The statistical approach to X-ray analysis. V. Vand and R. Pepinsky. *State College: X-ray and Crystal Analysis Laboratory of the Pennsylvania State University* (1953) xvi + 98 *pp.*

Review in *Acta cryst.*, **7**, 525 (*July*, 1954).

548.73 : 539.155.4

Variety of our sources of information on Avogadro's number and other constants. *See Abstr.* 9535

548.732

9764. Generalization of the Bragg–de Broglie principle of focusing. A. J. Rose. *Acta cryst.*, **7**, 483–6 (*July*, 1954) *In French.*

On the basis of this principle the author has studied the focusing of a pencil of X-rays diffracted by lattice planes inclined to the reflecting face of the crystal. A discussion is given of applications to emission spectroscopy and to the formation of radiographic images of thin crystal plates. A.

548.733

9765. Adaptation of a Geiger-counter X-ray diffractometer for high temperature investigations. P. Chiotti. *Rev. sci. Instrum.*, **25**, 683–8 (*July*, 1954).

The construction of a specimen holder and furnace for use as an auxiliary piece of equipment with a North American Phillips Company high-angle goniometer is described. The apparatus can be used for obtaining X-ray diffraction patterns at temperatures up to 1600°C, and at pressures in the range of 2×10^{-6} to 3×10^{-5} mm Hg. A.

548.733 : 536.581

9766. A precision micro-thermostat for crystal X-ray studies. P. J. A. McKeown. *J. sci. Instrum.*, **31**, 271–3 (*Aug.*, 1954).

The furnace construction and temperature controlling circuit are described for a microthermostat used in conjunction with an X-ray single crystal spectrometer from room temperature to above 700°C. Estimates of temperature accuracy and gradients are given. A.

548.734

9767. Contribution to the study of the absorption of X-rays by curved crystals in the neighbourhood of the Bragg angle. G. Barrère. *C.R. Acad. Sci.* [*Paris*] **238**, 2098–9 (*May* 24, 1954) *In French.*

See Abstr. 7868 (1954). The effects there described can be obtained with bent crystals provided the bending is done carefully. A. R. STOKES

548.734

9768. The effect of anisotropic thermal vibration on the atomic scattering factor. W. Cochran. *Acta cryst.*, **7**, 503–4 (*July*, 1954).

A discussion of the effect of anisotropic thermal vibration of the atoms in a crystal on the intensity of the Bragg reflections leads to a method by which these anisotropic temperature factors can easily be evaluated numerically. A.

548.734.2 : 548.737

9769. Determination of absolute configuration by Laue photographs. H. J. Grenville-Wells and K. Lonsdale. Letter in *Nature* [*London*] **173**, 1145–6 (*June* 12, 1954).

Bijvoet's method [Abstr. 9160–1 (1951)] of obtaining absolute configurations of optically active molecules is modified by taking a Laue photograph in such a way that the appropriate exciting wavelength is selected from the incident continuous radiation. This is more convenient than the use of characteristic radiation and also means that the effect of variation of the exciting wavelength can be studied. A. R. STOKES

548.735

9770. Solution of the phase problem. I. The centrosymmetric crystal. H. Hauptman and J. Karle. *Wilmington: the Letter Shop* (1953) 87 *pp.* [*A.C.A. Monograph No.* 3].

Probability distributions have been obtained for a structure factor based upon the knowledge of certain sets of intensities or phases. The probability that a structure factor be positive may then be inferred from these distributions. This leads to a routine and practical scheme for phase determination, valid for all centrosymmetric space-groups and needing no *a priori* knowledge of any phase. Only routine, but often tedious, mathematical computations are required to determine once and for all a specific procedure to be used for each space-group. These have been carried out in detail for space-group $P\bar{1}$ and, to a lesser extent, for $P2_1/a$. The procedure is readily adapted for IBM [International Business Machines] techniques and may often be carried out in part on a hand computer. One requires to know only a sufficient number of X-ray intensities and the chemical composition of the crystal. The methods appear to be useful even for the most complex crystals, provided only that the number of observed X-ray intensities is large enough. Illustrative examples have been worked out in detail for the naphthalene structure, and a simple geometrical interpretation of the method is given. A. R. STOKES

548.735

9771. Have Hauptman and Karle solved the phase problem? W. Cochran and M. M. Woolfson. Note in *Acta cryst.*, **7**, 450–1 (*May*, 1954).

See preceding abstract. The authors conclude, from a consideration of the equations involved, that the method of Hauptman and Karle is no more useful than other direct methods already in use [e.g. Harker and Kasper, Abstr. 3015 (1948)]. A. R. STOKES

548.735

9772. The statistical approach of Hauptman and Karle to the phase problem. V. Vand and R. Pepinsky. Note in *Acta cryst.*, **7**, 451–2 (*May*, 1954).

See preceding abstracts. The authors claim that

the statistical approach, applied to structures of space-group $P\bar{1}$, is liable to give an incorrect solution resembling the Patterson function rather than the structure and this view has been confirmed by a test on a hypothetical 4-atom structure; while its application to structures of higher symmetry gives results equivalent to Patterson–Harker sections. A. R. STOKES

548.735

9773. A note on the solution of the phase problem. H. HAUPTMAN AND J. KARLE. Note in *Acta cryst.*, **7**, 452–3 (*May*, 1954).

A reply to objections raised by Cochran and Woolfson, and Vand and Pepinsky (see preceding abstracts). It is claimed that the statistical approach will always lead to a correct solution provided a sufficiently large number of terms can be used in the syntheses. A. R. STOKES

548.735

9774. X-ray anti-reflections in crystals. II. Calculation of the integrated reflection and integrated anti-reflection for an internal reflection. G. N. RAMACHANDRAN. *Proc. Indian Acad. Sci. A*, **39**, 65–80 (*Feb.*, 1954).

Using the theory developed in Pt I [Abstr. 874 (1954)], the integrated values of the reflected and the anti-reflected intensity are obtained analytically for an internal reflection of a perfect crystal. Three special cases are considered, namely a symmetrical reflection, an asymmetrical reflection and also when absorption is very heavy. It is found that when absorption is large, the formula for integrated reflection reduces to that for a mosaic crystal, which may be physically explained by the fact that multiple reflections are not allowed to play a prominent part owing to the beam being quickly attenuated by absorption. A.

548.735

9775. A suggested explanation of the occurrence of forbidden X-ray reflexions in the σ-phase. J. A. BLAND. *Acta cryst.*, **7**, 477–8 (*July*, 1954).

"Forbidden reflections" in the Ni–V σ-phase reported by previous workers have been confirmed. Their explanation, which requires ordering in the structure, is discussed and an alternative explanation, based on the Renninger "double reflection" effect, is proposed. The conditions for the occurrence of the double reflections are examined and are shown to be particularly favourable in the present problem. A.

548.735

9776. Sign determination in crystal structure analysis. K. LONSDALE AND H. J. GRENVILLE-WELLS. *Acta cryst.*, **7**, 490–1 (*July*, 1954).

Selection rules (applying to centrosymmetrical crystals only, but for all types of Bravais lattice) are given in tabular form for the correct choice of three X-ray reflections to which arbitrary signs may be applied as the initial step towards sign determination by statistical methods. A.

548.735

9777. X-ray diffraction by close-packed crystals with "growth stacking faults" assuming an "*n*-layer influence." R. GEVERS. *Acta cryst.*, **7**, 492–4 (*July*, 954).

The X-ray intensity diffracted by close-packed crystals with "growth stacking faults" is calculated in the case of a general "*n*-layer influence." A.

548.735

9778. Approximate method of evaluating lattice sums of r^{-n} for graphite. A. D. CROWELL. *J. chem. Phys.*, **22**, 1397–9 (*Aug.*, 1954).

The graphite lattice is approximated by a set of planes in which the carbon atoms are assumed to be distributed with uniform density. It is shown that the lattice sums of r^{-n} taken over the graphite planes can then be expressed directly in terms of tabulated functions. The results of the approximation are compared with the results obtained by direct summation. A.

548.735.44

9779. Double Fourier-synthesis. Punched card method. G. KARTHA. *J. Indian Inst. Sci. A*, **35**, 332–8 (*Oct.*, 1953).

The use of punched card methods in crystal structure analysis has the advantage of speeding up the enormous amount of computational work involved in these investigations. Two methods are suggested for the evaluation of electron density distributions using double Fourier-synthesis. Of these two methods, complete details have been worked out for the latter one using the tabulator for summing up the series. A.

548.735.44

9780. X-ray line broadening and pure diffraction contours. R. I. GARROD, J. F. BRETT AND J. A. MACDONALD. *Austral. J. Phys.*, **7**, 77–95 (*March*, 1954).

In analysing the data from experiments designed to distinguish between particle size and distortion broadening from polycrystalline materials, it is customary either to employ correction formulae to obtain the true broadening β, or to derive the pure diffraction contour in terms of a Fourier series whose coefficients may be evaluated from the experimental line profiles. The first method leads to values of β that are critically dependent upon the particular functions chosen to represent the diffraction line profiles and the second method, whilst removing this ambiguity, only yields the pure diffraction contour numerically and not analytically. By applying Fourier methods, it is shown that the pure diffraction contours associated with particular causes of broadening can in fact be identified with certain types of analytic functions. In particular, the Cauchy and Gaussian distributions, which have often been arbitrarily employed in the past to represent the pure diffraction contour and experimental line profiles, are only strictly applicable to particular types of particle size and lattice distortion effects respectively. The case of combined size and distortion broadening is also considered, and for pure particle size broadening correction curves are derived corresponding to different types of particle size distributions. A.

548.736.3

9781. Studies on the texture of crystals. I. NaCl, KCl and MgO. V. M. PADMANABHAN. *J. Indian Inst. Sci. A*, **36**, 104–10 (*April*, 1954).

The X-ray studies on the texture of crystals using internal reflections have been extended to three

crystals, viz. rock-salt, magnesium oxide and potassium chloride. The rock-salt specimen was found to be ideally mosaic and showed an increase in the intensity of internal reflection with increase of thickness, as is to be expected theoretically. The melt-grown MgO crystal was nearly perfect, while KCl was mosaic. A.

548.736.3

9782. The crystal structure of $Cs_2I_8(Cs_4I)$. E. E. Havinga, K. H. Boswijk and E. H. Wiebenga. *Acta cryst.*, **7**, 487–90 (*July*, 1954).

548.736.4

9783. The determination of the crystal structure of $Ni_4Mn_{11}Al_{60}$. K. Robinson. *Acta cryst.*, **7**, 494–7 (*July*, 1954).

548.736.4

9784. Lattice parameters of the $FeFe_{(2-x)}Cr_xO_4$ spinel system. H. J. Yearian, J. M. Kortright and R. H. Langenheim. *J. chem. Phys.*, **22**, 1196–8 (*July*, 1954).

Spinels of the $FeFe_{(2-x)}Cr_xO_4$, $0 \leqslant x \leqslant 2$, system have been made by reduction of the corresponding sesqui-oxide solid solution at 1180°c, 1100°c and 950°c and the lattice parameters determined at room temperature. The solutions of approximately stoichiometric composition have lattice parameters which vary with x in a non-linear manner from $8{\cdot}396 \pm 0{\cdot}002$ Å at $x = 0$ to $8{\cdot}376 \pm 0{\cdot}002$ Å at $x = 2$. The four essentially linear segments comprising the total curve are interpreted as follows: from $x = 0$ to $x = 0{\cdot}3$ the structure is completely inversed; from $x = 1{\cdot}28$ to $x = 2{\cdot}0$ it is completely normal; between these regions reversion from the inversed to the normal form occurs in two successive stages. Oxygen-rich spinels crystallized at 950°c show the same general variations of parameter but the region of complete inversion extends to approximately $x = 0{\cdot}6$. A.

548.736.5

9785. Crystal structure determination from an X-ray powder diffraction pattern of β-$Mg_2(OH)_3Cl$. P. M. de Wolff and D. Kortlandt. *Appl. sci. Res. B*, **3**, *No.* 6, 400–8 (1954).

The orthorhombic compound β-$Mg_2(OH)_3Cl$ is isotypic with atacamite, $Cu_2(OH)_3Cl$. The precise determination of its atomic parameters is described as an example of the possibilities offered by high-resolution powder diffraction methods. The results prove that from the irregular (4 + 2) co-ordination of the cations in atacamite, at most a trace is left in the Mg-compound. A.

548.736.6

9786. A review of the Al–O and Si–O distances. J. V. Smith. *Acta cryst.*, **7**, 479–81 (*July*, 1954).

A review of the measured Al–O and Si–O distances leads to the values Al–O = $1{\cdot}78 \pm 0{\cdot}02$ Å and Si–O = $1{\cdot}60 \pm 0{\cdot}01$ Å. These values are of use in locating the positions of Al and Si atoms in felspar or other structures by accurate measurements of distances in oxygen tetrahedra. A.

548.736.6

9787. Hafnium silicides. B. Post, F. W. Glaser and D. Moskowitz. Letter in *J. chem. Phys.*, **22**, 1264 (*July*, 1954).

HfSi and $HfSi_2$ were prepared and were found to be similar in structure to ZrSi (hexagonal) and $ZrSi_2$ (orthorhombic). A. R. STOKES

548.736.6

9788. X-ray and differential thermal studies of some Indian montmorillonites. A. K. Bose and P. Sengupta. Letter in *Nature* [*London*] **174**, 40–1 (*July* 3, 1954).

548.737

9789. An X-ray study of *o*-phthalic acid. D. M. Chakraburtty. *Indian J. Phys.*, **28**, 129–32 (*March*, 1954).

From morphological and X-ray study the correct unit cell dimensions for the ortho phthalic acid crystal was found to be $a = 5{\cdot}05$ Å, $b = 14{\cdot}03$ Å, $c = 9{\cdot}325$ Å and $\beta = 93°, 30'$, number of molecules per unit cell being 4. The extinction conditions of spots from the Weissenberg pictures suggested two space-groups C_{2h}^6 and C_s^4 for the crystal. X-ray analysis, together with chemical consideration and pyro-electric test, suggest the correct space-group for *o*-phthalic acid to be C_s^4 or *Cc*. A.

548.737

9790. Structure of optically active compounds in the solid state. J. M. Bijvoet. *Nature* [*London*] **173**, 888–91 (*May* 15, 1954).

Outlines the heavy-atom technique of phase determination in the Fourier synthesis (in the form of the isomorphous substitution method), with special reference to the non-symmetrical case. The phase determination for this case implies the solution of the problem of the absolute configuration of optically active compounds. The configuration of the heavy atom is first determined by the Patterson synthesis; the isomorphous substitution introduces an extra electron density (the "test density"). The unknown phases are ultimately calculated from known amplitudes. As far as the location of the waves is concerned, the problem involved, consisting in determining the sign of the phase angle, is solved by the trick of using X-rays of special wavelength, which just excite the heavy atoms, thus producing anomalous scattering of the X-rays; this is used for distinguishing between the 2 possible phase differences arising between the X-ray beams diffracted from the Fourier wave of the heavy atom configuration and that of the rest of the crystal. The whole procedure suggested is summarized in a chart for different cases of complexity. F. LACHMAN

548.74 : 539.27

9791. The diffuse scattering of electrons by thermal elastic waves in crystals. J. Laval. *C.R. Acad. Sci.* [*Paris*] **238**, 2068–70 (*May* 24, 1954). *In French.*

This follows precisely the same laws as govern the scattering of X-rays. A. D. LE CLAIRE

548.74 : 539.27

On plane-lattice effect in electron diffraction investigations on various metal layers. *See Abstr.* 9672

GEOPHYSICS 55

550.341

9792. Note on Love waves in a homogeneous crust laid upon heterogeneous medium. II. S. C. DASGUPTA. *Indian J. theor. Phys.*, **1**, 121–4 (*Dec.*, 1953).

For previous part, see Abstr. 2090 (1953). It has been shown in this paper that propagation of Love waves is possible in a homogeneous medium in which both rigidity and density vary as $\cosh^2(z/\lambda)$, λ being a constant and z the depth below the surface of the substratum. A.

550.341 : 539.31

An investigation of the finite strain in an isotropic material subjected to hydrostatic pressure and its seismological applications. *See Abstr.* 9674

550.342 : 550.834 : 534.213

9793. Short range propagation of mechanical disturbances in the ground. B. J. STARKEY AND C. M. LOCK. Letter in *J. appl. Phys.*, **25**, 816–17 (*June*, 1954).

The ground disturbances at distances of up to 50 ft from a very short mechanical impulse were recorded both on the surface and at various depths. An analysis of the records was made in conjunction with an examination of a vertical section of the ground. It is assumed that the energy from a point source, travelling downwards, excites modes of simple oscillation which correspond to the different layers having different properties; these oscillations are propagated along the layers with energy continually interchanged between them by leakage. This assumption enables a plausible explanation to be given of a particular disturbance trace. H. J. H. STARKS

550.367 : 523.72

9794. Heat generation in the earth by solar neutrinos. A. M. CORMACK. Letter in *Phys. Rev.*, **95**, 580–1 (*July* 15, 1954).

The view is advocated that as a consequence of the assumption of the carbon cycle for the energy generation in the sun, the surface of the earth should receive about $7{\cdot}4\times10^{10}$ neutrinos/cm^2 sec. It is then stated that if inelastic collisions take place between neutrinos and electrons (which should occur if the neutrino has a magnetic moment which can interact with the electron magnetic moment), the energy supply to the electrons will be dissipated in the earth. This source of heat is estimated to exceed other sources usually considered in geophysics. A diagram shows the heat generation in the earth as a function of the neutrino magnetic moment. A. BEER

550.38 : 525.3

9795. Rock magnetism and polar wandering. J. HOSPERS. *Nature* [*London*] **173**, 1183–4 (*June* 19, 1954).

Several studies of the directions of the natural permanent magnetization of comparatively recent igneous and sedimentary rocks indicate that in recent geological times the geomagnetic poles have centred on the geographic ones. Assuming this holds for earlier times, studies of older rocks should reveal any movement of the geographic poles in the past. Measurements of some Tertiary and Quaternary rocks suggest that the amount of polar wandering has been much less than that assumed by Wegener and others. The results for Eocene lava flows in Ireland indicate some change of relative positions of geographic axis and crust, but this may be due to a relatively local crustal movement. A. T. PRICE

550.384

9796. Time variation of the earth's magnetic field at the time of bay-disturbance. Y. KATO AND J. OSSAKA. *Rep. Ionosphere Res. Japan*, **6**, 37–41 (*March*, 1952).

Time variation, dH/dt, of the geomagnetic field at the time of bay disturbance was investigated by using induction magnetograph records, and it was found that the changes of dH/dt are remarkable only at the initial part of bay disturbance, becoming calm at the time when the bay reaches its maximum amplitude. A.

550.384 : 525.24

9797. The effect of a solar eclipse on the earth's magnetic field. I. YOKOYAMA AND T. RIKITAKE. Note in *Rep. Ionosphere Res. Japan*, **5**, 100–2 (*June*, 1951).

550.384 : 551.510.535

9798. Geomagnetic and ionospheric relationships. R. P. W. LEWIS AND D. H. MCINTOSH. *J. atmos. terrest. Phys.*, **4**, 44–52 (*Sept.*, 1953).

The effect of magnetic "disturbance" on various parameters, both geomagnetic (measured at Eskdalemuir) and ionospheric (measured at Slough), is investigated by choosing days on which the K_p sum is markedly above or below those of adjacent days. Most of the parameters show a peak or trough corresponding to that of disturbance, and following it by periods of from 0 to 18 hours. An extension of the investigation to measurements made at Huancayo shows mainly similar results. Particular attention is called to some peculiar seasonal effects; also to features of the sporadic E-layer occurrence at Slough and of the vertical movement of the $F2$-layer at Huancayo. A.

550.385

9799. Further notes on a new theory of magnetic storm. Y. KATO. *Rep. Ionosphere Res. Japan*, **5**, 75–83 (*June*, 1951).

The following results are obtained with the newly designed induction magnetograph: (1) the type of the change of dH/dt at the sudden commencement of the magnetic storm varies according as it occurs in the night or day hemisphere, i.e. the oscillation of dH/dt is very remarkable in day-time, while weak at night; (2) the oscillation dH/dt of sudden commencement which frequently occurred in day-time is thought to be due to the fluctuation of conductivity of S_D, which is remarkable in the day hemisphere, and the gradual part in dH/dt of sudden commencement to be due to the symmetrical part called D_{st} by E. H. Vestine. A.

550.385

9800. Some characteristics of magnetic storms. I. Magnetic storm on August 3, 1949. N. FUKUSHIMA. *Rep. Ionosphere Res. Japan*, **5**, 85–97 (*June*, 1951).

Main results obtained in this study are as follows:

(1) a perturbation of magnetic field like the bay disturbance took place about one hour before the sudden commencement of this storm; (2) magnitude of the sudden commencement was markedly large in the auroral zone, especially in the sunlit hemisphere; (3) S_D-component of the magnetic disturbance began to develop soon after the sudden commencement in the case of this magnetic storm; (4) fluctuations of geomagnetic field in the high-latitude regions were composed chiefly of D_{st}-component in the initial phase, but of S_D-component in the main and recovery phases of this storm; (5) ionospheric disturbance accompanying this magnetic storm was a typical ionospheric storm in the middle latitude regions. A.

550.385

9801. Distribution of SC* of magnetic storms. T. NAGATA. *Rep. Ionosphere Res. Japan*, **6**, 13–30 (*March*, 1952).

The distribution of the preliminary reverse impulse of SC* of magnetic storms with respect to local time and latitude was examined with the aid of the printed copies of magnetograms of the five magnetic stations in U.S.A. during three and a half years and of three examples of world-wide distributions of SC* of individual magnetic storms. For an example among the three, the general aspect of progress of SC* was examined in detail with respect to time by means of quick-run magnetograms. The result showed that (*a*) the preliminary reverse impulses appear principally in the afternoon; (*b*) the magnitude of the preliminary reverse impulse as well as its ratio to the corresponding main impulse increase markedly with geomagnetic latitude; (*c*) the preliminary reverse impulse precedes by 1 or 2 minutes the main impulse of SC*, which takes place almost simultaneously with the ordinary SC in low latitude zones; and (*d*) it seems probable that the electric current system equivalent to the distribution of the preliminary reverse impulses is a clockwise current vortex centred in the polar region in the afternoon hemisphere. A significant result may be that a branch stream of ionized corpuscles arrives at or approaches the upper atmosphere of the polar region at the time of sudden commencement of magnetic storms. A.

550.385 : 523.746.5

9802. The distribution of great and small geomagnetic storms in the sunspot cycle. H. W. NEWTON AND A. S. MILSOM. *J. geophys. Res.*, **59**, 203–14 (*June*, 1954).

The distributions of (1) great geomagnetic storms (2) small storms with "sudden commencement" (SC) and (3) small non-SC storms through the sunspot cycle are examined. There is a close accordance between the averaged sunspot curve for the past seven cycles and the averaged curve for geomagnetic storms (1) and (2), which is shared by the giant sunspots, solar flares of greatest magnitude, and notable auroral displays. For the small non-SC storms, the distribution within the sunspot cycle and also the extent of the relationship with sunspots at storm onset differ from those of the previous phenomena. The broad division of small storms according to the SC criterion appears to be of intrinsic significance (probably related to their solar origin), since this division is supported by the differences found in (1) distribution in the sunspot cycle, (2) relation to sunspots, and (3) characteristics (in addition to the SC criterion), including a statistical difference in the tendency to recur at intervals of a synodic rotation (27 days), as announced by E. and O. Thellier in 1948 and confirmed in the present paper. The Greenwich analysis of 1928, showing the statistical non-recurrence of great storms, is brought up to date. A.

550.385 : 551.510.535

9803. Polar magnetic storms and geomagnetic bays. Appendix I. A theory of S_D-field. N. FUKUSHIMA AND T. OGUTI. *Rep. Ionosphere Res. Japan*, **7**, 137–46 (*Dec.*, 1953).

In the current-system for the S_D field deduced from actual analysis of geomagnetic data, the polar parallel current flows to the direction of about 7·5 hr meridian, while the mode of current flow in lower latitudes is almost coincident with Chapman's idealized S_D current-system. From the standpoint of the dynamo theory, the ionospheric condition that the ratio of integrated value of σ_2 to that of σ_1 is $\frac{1}{2}/1$ gives rise to a satisfactory mode of current flow in the polar and middle latitude regions in the calculated S_D current-system. The above ionospheric condition suggests that the current-system will be situated lower than 150 km in height. A.

550.837/.838

9804. Basic theory of the magneto-telluric method of geophysical prospecting. L. CAGNIARD. *Geophysics*, **18**, 605–35 (*July*, 1953).

From Ampere's law (for a homogeneous earth) and from Maxwell's equations using the concept of Hertz vectors (for a multilayered earth), solutions are obtained for the horizontal components of the electric and magnetic fields at the surface due to telluric currents in the earth. The ratio of these horizontal components, together with their relative phases, is diagnostic of the structure and true resistivities of subsurface strata. The ratios of certain other pairs of electromagnetic elements are similarly diagnostic. Normally, a magneto-telluric sounding is represented by curves of the apparent resistivity and the phase difference at a given station plotted as functions of the period of the various telluric current components. Specific formulae are derived for the resistivities, depths to interfaces, etc., in both the two- and three-layer problems. For two sections which are geometrically similar and whose corresponding resistivities differ only by a linear factor, the phase relationships are the same and the apparent resistivities differ by the same proportionality constant which relates the corresponding true resistivities. This "principle of similitude" greatly simplifies the representation of a master set of curves, such as is given for use in geologic interpretation. In addition to the usual advantages offered by the use of telluric currents (no need for current sources or long cables, greater depths of investigation, etc.), the magneto-telluric method of prospecting resolves the effects of individual beds better than do conventional resistivity methods. It seems to be an ideal tool for the initial investigation of large sedimentary basins with potential petroleum reserves. A.

550.93

9805. Natural radiocarbon measurements by acetylene counting. H. E. SUESS. *Science*, **120**, 5–7 (*July* 2, 1954).

Describes the technique developed by the U.S. Geological Survey which follows the method of Libby [*Radiocarbon dating*, Chicago (1952)] except that the barium chloride is replaced by strontium chloride for the precipitation of the carbonate and that smaller quantities of organic matter are used. It is shown that the counting system is remarkably stable and that the method is efficient and economical in manpower.

J. M. HOUGH

ATMOSPHERE . METEOROLOGY 551.5

551.508.71 : 621.317.79

9806. The carbon film electric hygrometer element. W. J. SMITH AND N. J. HOEFLICH. *Bull. Amer. Meteorol. Soc.*, **35**, 60–2 (*Feb.*, 1954).

A new type of electric hygrometer, the "carbon film element," is described. Its response to humidity changes is by electronic rather than electrolytic conduction. Main features are: high sensitivity to moisture changes, rapid response, absence of polarization effect, and a calibration independent of temperature between 0° and 40°c. Components of the carbon film, performance data, and manufacturing techniques are described. A.

551.508.94

9807. The agrimeter for continuous recording of the atmospheric electric field. J. A. CHALMERS. *J. atmos. terrest. Phys.*, **4**, 124–8 (*Oct.*, 1953).

A new apparatus is described for giving continuous records of the atmospheric electric field at the earth's surface, suitable for use in various conditions. Some typical records are given. A.

551.510.41

9808. Origin of nitrous oxide in the atmosphere. P. HARTECK AND S. DONDES. *Phys. Rev.*, **95**, 320 (*July* 15, 1954).

The origin of nitrous oxide in the atmosphere is due to the reaction between nitrogen molecules and oxygen atoms formed by the photochemical dissociation of ozone in the atmosphere. The steady state of 5×10^{-7} nitrous oxide in the atmosphere is due to the photochemical equilibrium between nitrous oxide formation and nitrous oxide decomposition, the latter in the upper atmosphere. A.

551.510.41 : 551.510.535

9809. On distribution of nitrogen in the upper atmosphere. T. SATO. *J. Geomagn. Geoelect.*, **5**, 71–82 (*Nov.*, 1953).

The dissociation of the nitrogen in the upper atmosphere is studied. It is considered that the nitrogen atom is produced by dissociative recombination of the positive nitrogen ion and the electron, and by the pre-dissociation by the absorption in the Lyman–Birge–Hopfield band. The former is effective in the region above about 120 km, while the latter is predominant below that level. The disappearance of the nitrogen atom is mainly due to the recombination by two- or three-body collision. The former mechanism of disappearance seems to be preponderant over the latter in the region where the dissociative recombination is conspicuous. Hence, two pairs of equations in an equilibrium state are solved. In the calculations, it is assumed that the temperature is constant throughout the region; the ratio of the concentration of the oxygen atom to that of the sum of the nitrogen is one-half; and the distribution of total nitrogen follows the law of gas in a static equilibrium, though the distribution of nitrogen molecule with height is not given previously. The results show that the nitrogen begins to dissociate at the level from 120 km to 130 km, and proceeds to completion at about 160 km–220 km. The concentration of the nitrogen atom has a peak at about 140 km–150 km altitude and its magnitude is of the order of 10^{10} cm^3. A.

551.510.5 : 551.510.535

9810. The vertical distribution of electrical conductivity in the upper atmosphere. H. MAEDA. *J. Geomagn. Geoelect.*, **5**, 94–104 (*Nov.*, 1953).

Using available materials of recent rocket measurements, a calculation is made to obtain the atmospheric and ionospheric models of the upper atmosphere between 60 km and 400 km. On the basis of these models the vertical distribution of electrical conductivity and its height-integrated values for three ionospheric regions *F*, *E* and *D* are obtained. The results show that the conductivity of the *E*-region, especially near 100 km, is predominant, so that this region is most probably effective for the electrical currents producing daily magnetic variations. A.

551.510.535

9811. Critical factors relating to the formation of the *E*-region of the ionosphere. K. RAWER AND E. ARGENCE. *Ann. Geophys.*, **9**, *No.* 1, 1–25 (1953) *In French.*

After giving briefly the general theory of formation of ionized regions, there is a review of the different experimental results obtained for the height of the *E*-region. Different assumptions regarding the origin of this region are examined: photoionization of molecular oxygen or ionization by soft X-rays. Both theories are examined with the aid of suitable models the parameters of which are indicated in detail. The theory of photoionization of O_2 is only admissible if this constituent is dissociated at a high altitude of about 130 km. On the other hand X-rays of solar origin will certainly produce some ionization at this altitude, but recent values of solar radiation obtained from an analysis of coronal emission result in a too high ionization between 95 and 110 km. A.

551.510.535

9812. Lunar tidal variations in the sporadic-*E* region. S. MATSUSHITA. *Rep. Ionosphere Res. Japan*, **7**, 45–52 (*June*, 1953).

Though the individual values of the *Es* data may have not enough accuracy to enable one to draw any tidal oscillation, the results of statistical studies may be considered as giving reliable semi-diurnal lunar tides in the *Es*-region. The maximum amplitude of the lunar semi-diurnal variation of *fEs*, for a period of

one year, resembles that of the $F2$, and in summer it is larger than that of the $F2$, especially in the middle latitudes. The magnitude of the height variation in the tide resembles that of the $F1$. The maximum of the height variation occurs approximately 6 hours after the lunar culminations, and the maximum for fEs occurs two or three hours later. If some assumptions for the Es-region are agreed to these phenomena may be explainable by drift movements with horizontal tidal winds. A.

551.510.535

9813. The connection between lunar height changes and lunar currents in the E-layer. M. H. JOHNSON. *J. geophys. Res.*, **59**, 247–51 (*June*, 1954).

The height changes produced by vertical electronic diffusion in the presence of negative ions are examined in some detail. Application of the results to the E-layer shows that a previous qualitative discussion remains valid. A.

551.510.535 : 621.396.11

9814. A subsidiary layer in the E region of the ionosphere. R. NAISMITH. *J. atmos. terrest. Phys.*, **5**, 73–82 (*May*, 1954).

Reasons and methods of identification are given for the recognition of an independent layer at 90–100 km height. It is suggested that the ionization in this layer results from the impact of meteors on the atmosphere and that it may therefore be called the meteoric E-layer. The distinctive properties may be used to extend the use of the ionosphere for intermediate distance radiocommunication. A.

551.510.535

9815. Simultaneous measurement of sweep frequency $h't$ and fct of the ionosphere. Y. NAKATA, M. KAN AND H. UYEDA. *Rep. Ionosphere Res. Japan*, **7**, 129–35 (*Dec.*, 1953).

Concerned with the simultaneous continuous recording of the virtual height and the critical frequency of the ionosphere, changing the frequency in the band from 4·9 to 9·0 Mc/s. The equipment adopted is briefly described, illustrating several examples of the records. A.

551.510.535

9816. Sweep-frequency $h't$ measurement of the ionosphere. Y. NAKATA, M. KAN AND H. UYEDA. *Rep. Ionosphere Res. Japan*, **7**, 1–6 (*March*, 1953).

An equipment for continuous recording of the h' variation of the ionosphere was constructed. At first the method adopted is briefly described, and then a few typical examples of the records are illustrated. Sudden change of $h'F2$ is most remarkable. A.

551.510.535

9817. A consideration of the mechanism of electron removal in the $F2$ layer of the ionosphere. T. YONEZAWA. *Rep. Ionosphere Res. Japan*, **7**, 15–20 (*March*, 1953).

A mechanism of electron removal in the $F2$-region, which consists in the transformation of atomic ions into molecular ones through charge transfer and the subsequent recombination of the latter ions with electrons, has been considered. It has been concluded that, although this mechanism may be capable of interpreting the attachment type of electron removal, it can hardly explain quantitatively the value of attachment coefficient, and besides, there remains a discrepancy between theory and observation concerning the value of scale height associated with the decrease in attachment coefficient with height. A.

551.510.535

9818. World-wide diurnal variations in the $F2$ region. C. W. ALLEN. *J. atmos. terrest. Phys.*, **4**, 53–67 (*Sept.*, 1953).

A study has been made of the diurnal variations of $F2$ critical frequencies and virtual heights as a function of phase of sunspot cycle, season, and geographic and geomagnetic position. The main results are derived from ten stations that are well observed at both sunspot maximum and minimum. The chief characteristics of f^0F2 may be described in terms of (*a*) the sunspot minimum anomaly, (*b*) the sunrise anomaly, and (*c*) the diurnal range anomaly. The features of these anomalies are evaluated quantitatively and then, as far as possible, the anomalies are extracted from the data to determine the normal curves. The world distributions of indices representing the anomalies are studied. The variations of the $F2$ virtual height are not related in any very significant manner to either the sunspot cycle or the f^0F2 diurnal curves. Some attempt at explanation of the anomalies has been made but no complete theory is available. Some effects are thought to be thermal or tidal oscillations, and evidence is given for the conclusion that $F2$-electrons disappear by a decay law that is independent of gas pressure. A.

551.510.535

9819. An interpretation of vertical incidence equivalent height versus time recordings on 150 kc/s. R. LINDQUIST. *J. atmos. terrest. Phys.*, **4**, 10–27 (*Sept.*, 1953).

Results of virtual height versus time vertical incidence pulse recordings, obtained on 150 kc/s, are presented and discussed. Monthly median values of the reflection heights are shown in a series of graphs. The coupling echo, predicted by current wave theory, is definitely shown to exist. The results of measurements during undisturbed and disturbed days are discussed. It is concluded that one form of echo regularly noticed during magnetically disturbed nights must be due to one type of sporadic E. Recorded groups and phase heights are compared and the differences checked against those predicted theoretically. Finally, the results are given of a preliminary investigation of the effects of solar flares. A.

551.510.535

9820. Ionization distribution in the F-region. B. CHATTERJEE. *Indian J. Phys.*, **28**, 53–66 (*Feb.*, 1954).

The height distribution of ionization in the composite F-region is calculated on the assumptions that the scale height (i.e. the temperature) increases and the recombination coefficient decreases with height in this region. The recombination coefficient is assumed to vary in terms of the reduced height, that is the height (above $F_{1\,max}$) measured in terms of the scale height and not in terms of the actual height as had been done earlier by Mitra [Abstr. 2843 (1953)] in making similar calculations. The present assumption automatically takes into account the effect of

rising temperature on the value of the recombination coefficient. Height distribution curves for high and low latitude stations are drawn for typical summer and winter conditions in the high atmosphere in the *F*-region. It is found that when the possible effects of ionospheric tidal drifts are taken into account, the forms of the distribution curves, as also the separation between the F_1- and F_2-layers, agree with those deduced from observational data. The investigation lends support to the hypothesis that the ionospheric regions F_1 and F_2 belong to a common bank of ionization produced by a common ionizing radiation from the sun. A.

551.510.535

9821. Electron resonance in ionospheric waves. C. O. HINES. Letter in *Nature* [*London*] **173,** 1087–8 (*June* 5, 1954).

Preliminary report of a new approach to the hydrodynamic wave theory of ionospheric travelling disturbances. Results appear more consistent with other estimates for the *F*2-layer. G. M. BROWN

551.510.535 : 538.566.3

Radio-wave propagation in the ionosphere. *See Abstr.* 9407, 9413–17

551.510.535 : 550.384

9822. The solar flare type variation in geomagnetic field and the integrated electric conductivity of the ionosphere. III. Effect of the earth. T. NAGATA AND M. TAZIMA. *Rep. Ionosphere Res. Japan.*, **5,** 113–21 (*Sept.*, 1951).

The internal part of s.f. variation field, which is due to the induced electric current within the earth, is almost proportional to its external part, the former being about 0·49 of the latter. So that the horizontal component of s.f. variation can be safely assumed to be 3/2 of the external part without phase shift. However, the mutual inductance between the ionosphere and the conductive earth is fairly effective upon the change in electric current which is responsible for s.f. variations. If the conductive earth is taken into account, the integrated electric conductivity of the ionosphere should be about three times as much as that estimated neglecting the effect of the earth. A.

551.510.535 : 550.384

9823. The solar flare type variation in geomagnetic field and the integrated electric conductivity of the ionosphere. IV. The conductivity of the ionosphere over Japan. T. NAGATA. *Rep. Ionosphere Res. Japan*, **5,** 123–8 (*Sept.*, 1951).

Sixty-two typical examples of the solar flare type variations observed at Kakioka during 1936–42 were statistically examined. With the aid of the transient dynamo theory, the average value of the integrated electric conductivity of the ionosphere over Japan was estimated from these data to be 7×10^{-8} e.m.u. A.

551.510.535 : 550.384

9824. On a change in geomagnetic declination accompanying intense sporadic *E* layer ionization. H. HOJO AND T. YONEZAWA. *Rep. Ionosphere Res. Japan*, **7,** 61–7 (*June*, 1953).

By an analysis of geomagnetic and ionospheric data observed at Kakioka and Kokubunji, respectively, it has been concluded that the geomagnetic declination shows a small deflection in the direction of amplifying its diurnal variation a few hours after the appearance of an intense *Es*-layer. This suggests that the intense *Es*-layer is more probably produced by ionization as a result of incidence of some sort of particles. A.

551.510.535 : 550.384

Geomagnetic and ionospheric relationships. *See Abstr.* 9798

551.510.535 : 550.385

9825. Variations of the F_2-layer occurring before geomagnetic storm. S. MATSUSHITA. Note in *Rep. Ionosphere Res. Japan*, **5,** 102–3 (*June*, 1951).

551.510.535 : 550.385

9826. Classification of *F*2-layer storms with respect to their world-wide distribution and characteristics of them (1st Report). H. UYEDA AND Y. ARIMA. *Rep. Ionosphere Res. Japan*, **6,** 1–12 (*March*, 1952).

*F*2-layer storms have no coincidence with sunspot activity, but close coincidence with magnetic storms. They may be classified into several types with respect to their world-wide distribution over the geomagnetic latitudes on a basis of either $foF2$ or h_pF2 (or $h'F2$). These types, not necessarily the same, but the near for both $foF2$ and h_pF2, seem to appear in special seasons respectively. Although each type of storm has its defined characteristics, every storm in the same type has individual properties so random that any completely idealized storm can seldom appear. Further, some properties such as the time of commencement of storm, range of storm, etc., are illustrated. A.

551.510.535 : 550.385

9827. On the variation of the *F*2 layer accompanying geomagnetic storms. K. SINNO. *Rep. Ionosphere Res. Japan*, **7,** 7–14 (*March*, 1953).

The separation of the variations in $foF2$ and $h'F2$ accompanying geomagnetic storms into two parts depending on the universal and the local time, respectively, has been attempted by the same method as that employed in the case of geomagnetic force components. The seasonal and latitudinal characteristics of the two parts and the developing process of the local-time part of the variations have been revealed. The deductions are that the variation in the local-time part is excited by the so-called "S_D current" associated with the geomagnetic storm and that any trace of moving disturbance from the auroral zone reported by some workers is not clear enough to be found. A.

550.510.535 : 550.385

9828. Ionospheric storms in the auroral zone. T. NAGATA AND T. OGUTI. *Rep. Ionosphere Res. Japan*, **7,** 21–8 (*March*, 1953).

Characteristics of the daily and monthly variations of abnormal changes of $foF2$ associating with magnetic storms at College, Alaska, are statistically examined. The results are as follows: (i) $foF2$ decreases due to magnetic storms so far as *F*2-layer in the auroral zone is situated in the sunlit region, while it increases in dark hours. (ii) This change of $foF2$ begins usually just after the commencement of a magnetic storm, and reaches a state of saturated activity a few hours later. (iii) Theoretically, the

f_0F2 depression at sunlit times may be attributed to the expansion of $F2$-layer due to heating caused by impinging corpuscles. A.

551.510.535 : 550.385

9829. A theory of distribution and variation of the ionospheric $F2$ layer. K. MAEDA. *Rep. Ionosphere Res. Japan*, **7**, 81–107 (*Sept.*, 1953).

A brief description is given of results leading to the conclusions of inhibition of vertical ionospheric current, enhancement of conductivity, dynamo current and vertical drift of charged particles near the geomagnetic equator and suppression of daytime electron density of the $F2$-layer caused by an upward drift of electrons. The treatment is extended to the case of ionospheric storms accompanied by geomagnetic storms. Comparison of the theoretical and observational results is made for the cases of undisturbed as well as disturbed states of $F2$-layer. The agreement is generally good for the undisturbed case, but not quite satisfactory for the disturbed case. The dynamo mechanism in the ionosphere and hypothetical wind system during a storm are discussed. A.

551.510.535 : 550.385

9830. Ionospheric variations associated with geomagnetic disturbances. I. Variations at moderate latitudes and the equatorial zone, and the current system for the S_D field. S. MATSUSHITA. *J. Geomagn. Geoelect.*, **5**, 109–35 (*Dec.*, 1953).

Variations in the densities and heights of the ionospheric *Es*- and $F2$-regions during magnetic storms are studied. At moderate latitudes in summer solstice and at the equatorial zone, the disturbance variation of the *Es* in both local time (S_D) and storm time (*Dst*) is obtained by statistical examination, although the individual values of the *Es* data may not always be accurate. The amplitude of the S_D variation of the *Es* at the moderate latitudes is about 0·5 Mc/s in frequency (15% for mean ionized density), and the phase of the variation seems to be opposite to that of the $F2$. At the equatorial zone, the S_D variations of the *Es*- and the $F2$-regions and the *Dst* variation for f_0F2 are rather peculiar for the phase, compared with those at the moderate latitudes. The geomagnetic S_D variation at this zone is also a little different from that in the moderate latitudes. In addition the current system for the S_D field is calculated by the dynamo theory, taking into consideration the anisotropic electrical-conductivity. A production mechanism of the *Es* is supposed, and the possibility that the ionospheric S_D variations are due to the effect of a drift by the earth's magnetic field and the electric field of the S_D current is discussed. A.

551.510.535 : 551.557

9831. Winds in the ionospheric regions. S. DEB. *J. atmos. terrest. Phys.*, **4**, 28–43 (*Sept.*, 1953).

The problem of wind circulation in the upper atmosphere, above the 100 km level is investigated, following a method of synthesis by combining theoretical reasonings with experimental data. Starting with the available informations on height distribution of temperature at three different latitudes, viz. 30°N, 45°N and 80–90°N, horizontal pressure gradients and, hence, wind velocities at different heights are computed. The effect of kinematic viscosity on the wind velocities is taken into account in general terms. The final results suggest three possible models of wind circulation in the region 100–400 km. In order to judge the relative merits of these models, the results of wind measurement in this region, as are available, are collected and tabulated. It is found that one, at least, of the theoretical models agrees well with the observed wind data. According to this model wind is south-west in the E- and $F1$-regions of the ionosphere and north-east or east in the $F2$-region. The wind velocity rises with height from 50 m.p.h. to 100 km to over 200 m.p.h. above 200 km. There is a seasonal variation in the magnitude of the velocity. This is found to be distinctly lower in summer. The model, however, does not predict any change in direction—diurnal or seasonal—as has been reported by observers. Possible explanations of these discrepancies are discussed. The height distributions of temperature on which the theoretical models are based, are critically examined. Necessity for further rocket observations in different latitudes is emphasized. A.

551.510.535 : 621.396.11

9832. The effect of solar corpuscles in the ionosphere. W. DIEMINGER. *Arch. elekt. Übertragung*, **8**, 259–68 (*June*, 1954) *In German.*

The paper discusses typical changes occurring in the ionosphere during the penetration of solar corpuscles inside and outside the zone of northern lights. The theory of Chapman–Ferraro by Martyn is extended so as to allow the observed phenomena in the ionosphere and in terrestrial magnetism to be explained in the same basic manner. The essential idea is here that the corpuscles emitted from the "ring current" transfer the radial field of polarization of this current to the zone of northern lights. The meridional electrical field set up there brings current systems into motion and modifiies as a secondary effect the distribution of the charge carriers in the $F2$-layer. A.

551.574.1

9833. Fog formation due to self nucleation. H. WAKESHIMA. *J. Phys. Soc. Japan*, **9**, 400–6 (*May–June*, 1954).

Discussing the fog formation in adiabatically expanded dust- and ion-free moist air, the relation between the droplet size, the time required for the growth of droplets and the rate of self-nucleation are derived, based on the assumption of a simple model process. These relations, when applied to the case of adiabatic expanion at the so-called cloud limit, give a plausible order of magnitude for these quantities. In particular, the discrepancy between the current theory of self-nucleation and the known critical expansion ratio 1·37 can be eliminated. A.

551.574.1

9834. Fog formation due to self nucleation. II. H. WAKESHIMA. *J. Phys. Soc. Japan*, **9**, 407–13 (*May–June*, 1954).

In Pt I, the change of temperature of the air after expansion was not taken into account. In this part the influence of the rise in temperature of the air after an initial cooling due to the heat transmission from

outside, and the heat liberation inside, the gas is treated in an approximate way and the results discussed. A.

551.574.1 : 532.623

Photographic investigation of the projection of droplets by bubbles bursting at water surface. *See Abstr.* 8954

551.577.34

9835. On the secular variation of rainfall at Adelaide. E. A. CORNISH. Note in *Austral. J. Phys.*, **7**, 334–46 (*June*, 1954).

551.578

9836. The spontaneous freezing temperatures of melted snow and of small water drops, H. C. VAUGHAN. *Bull. Amer. Meteorol. Soc.*, **35**, 52–5 (*Feb.*, 1954).

The spontaneous freezing temperatures of samples of melted snow collected at hourly intervals during several storms are reported. The freezing temperatures were found to range from $-8{\cdot}3$ to $-16{\cdot}8$°C. In most cases the freezing temperature remained fairly constant over periods of several hours. Gross variations in the pollution of the lower atmosphere caused no obvious effect on the observed freezing temperatures. It is suggested that the observed freezing temperatures represent the temperatures of initial formation of the snow crystals. A few experiments on the freezing temperatures of small drops were made with a technique such that all drops were formed from the same bulk sample without any danger of contamination. In all cases the freezing temperatures of the drops were well below that of the bulk water. The freezing temperature decreased with decreasing drop size, but there was a relatively large variation for a given drop size. A.

551.578.4

9837. On the nuclei of freezing in the atmosphere. G. SOULAGE. *C.R. Acad. Sci.* [*Paris*] **239**, 74–6 (*July* 5, 1954) *In French.*

A method of isolating the nuclei is described by repeated precipitation of atmospheric ice on a glass plate and an examination with a microscope. Experiments showed that temperatures of about −15°C were necessary to cause freezing. The nuclei appear to be present in the atmosphere to the order of 1 per litre and to have irregular shapes with a diameter of the order of 7–25 μ. J. M. HOUGH

551.593.1 : 525.722

9838. Scintillation studies on the Jungfraujoch. H. SIEDENTOPF AND H. ELSÄSSER. *Z. Astrophys.*, **35**, No. 1, 21–35 (1954) *In German.*

The modulation of visual stellar radiation by the atmospheric scintillation has been observed with a multiplier-photometer at the 51 cm telescope on Jungfraujoch in its dependence on zenith distance, aperture and time-constant of the recording apparatus. The comparison with results of similar observations near sea level shows that the mean amplitude of scintillation in the altitude of 3600 m is distinctly smaller. The influence of scintillation on the accuracy of photoelectric photometry is discussed, and the importance of the small frequencies in the scintillation-spectrum or the long wavelengths in the scintillation-pattern emphasized. A.

551.593.5

9839. Day-sky brightness measured by rocketborne photoelectric photometers. H. A. MILEY, E. H. CULLINGTON AND J. F. BEDINGER. *Trans Amer. Geophys. Un.*, **34**, 680–94 (*Oct.*, 1953).

Several experiments have been conducted since 1946 to measure skylight in the upper atmosphere. From the results, it appears that skylight consists of (1) sunlight scattered by the atmosphere and (2) day airglow (light originating in the upper air by other means than Rayleigh scattering). The scattered-light values are large at the ground but decrease rapidly (almost proportional to atmospheric density) until at about 30 km the sky is relatively black, the measured values being about 2 to 3% (depending on direction) of those recorded at the ground level. The scattered light becomes unimportant in comparison with airglow at about 35 to 40 km. Day airglow appears to be nearly constant in the range 40 to 130 km, and is much larger than expected. Photometers employing interference filters gave day-airglow values which are of the order of 10^4 times the corresponding night-airglow values. Further evidence of large light values at high altitudes is given by photographs of clouds made at an altitude of 70 km. The nature and exact locations of these clouds are to be determined. They appear near enough to have been in the cold layer at about 80 km. A.

551.593.5 : 525.723

9840. Extinction measurements on the Jungfraujoch. H. ELSÄSSER. *Z. Astrophys.*, **35**, *No.* 1, 36–42 (1954) *In German.*

The amount of atmospheric extinction at three wavelengths was measured by photoelectric methods. The comparison with a pure Rayleigh atmosphere leads to the result that most nights have a small dust absorption even at 3600 m. The expression $k_D(\lambda) = \beta \times \lambda^{-\alpha}$ for the extinction k_D by dust particles shows two types of nights: for some nights the exponent scatters round $\alpha = 1{\cdot}3$, for the others round $\alpha = -1{\cdot}0$. The coefficient β has values between $0{\cdot}00$ and $0{\cdot}03$. A.

551.593.7

9841. Measurement of the dispersion of the degree of polarization at the zenith between 4000 and 8500 Å. R. DUMONT. *C.R. Acad. Sci.* [*Paris*] **238**, 2512–14 (*June* 28, 1954) *In French.*

Describes the apparatus used and the preliminary results obtained at the Observatory of Haute-Provence in Sept., 1953. The results show a very complex dependence on the wavelength and on the height of the sun, but there was some mist at the time.

J. M. HOUGH

551.593.9

9842. Photoelectric studies of the night sky light. III. M. HURUHATA. *Rep. Ionosphere Res. Japan*, **6**, 31–5 (*March*, 1952). For Pt II, see Abstr. 1917 (1954).

Horizontal drift of the night sky light was studied by the observations of the infrared radiation over the whole sky. In eleven nights during the years 1949 and 1950, the drift was generally acknowledged except for one night. The direction of the movement was mostly from N.N.E. to S.S.W and the vice versa,

being perpendicular to the geomagnetic parallel. The speed of the drift seems to be several hundred kilometres per hour, southward drift being larger than the northward drift by nearly one hundred kilometres. A.

551.593.9

9843. The altitudes of the luminous layers in the earth's atmosphere. D. R. Bates and A. Dalgarno. *J. atmos. terrest. Phys.*, **4**, 112–23 (*Oct.*, 1953).

The claim of the observers that the main features of the airglow (other than the Meinel hydroxyl bands) originate from altitudes as great as several hundred kilometres is disputed. Consideration is given to the various excitation mechanisms which might conceivably be operative but even on the most favourable assumptions none appears likely to be sufficiently effective at such altitudes. In the case of certain of the emissions, such as the *D*-lines of sodium, it is contended that the theoretical arguments are unequivocal. A.

551.593.9

9844. The height of emission of the night sky green line. J. Dufay and M.-L. Tcheng. *Ann. Géophys.*, **10**, 1–8 (*Jan.–March*, 1954) *In French.*

In the authors' previous spectroscopic observations on the height of the layer emitting the [OI] line $\lambda = 5577$ Å at night, imperfect calibration of the absorbing screen, utilized for the standardization of the photometric plates, arose from the light scattered by the screen. With the screen densities corrected for this effect, the factor $K = J(70°)/J(20°)$ decreases on the average about 5 or 7%. Thus the altitude of the emitting layer is strongly increased and becomes nearly 215 km, in perfect agreement with the photoelectric observations made by D. Barbier, J. Dufay and D. Williams. A.

551.593.9

9845. Remarks on the height of the sodium layer responsible for crepuscular emission. R. Robley. *Ann. Géophys.*, **10**, 35–40 (*Jan.–March*, 1954) *In French.*

The examination of the curves of decreasing crepuscular *D*-line intensity at high latitudes suggests a correct application of the zenith-horizon method for determining altitude of the sodium layer. The shape of the curves leads to the supposition that the observed variations have their origin at the bottom of the layer. A.

551.593.9

9846. The effect of Rayleigh scattering and ground reflection upon the determination of the height of the night airglow. E. V. Ashburn. *J. atmos. terrest. Phys.*, **5**, 83–91 (*May*, 1954).

Chandrasekhar's theory of radiative transfer was used to calculate the effect of atmospheric scattering and ground reflection upon the determination of the height of the night airglow for values of the extinction coefficient, τ, 0·01, 0·05, 0·10, 0·15, 0·25 and 1·00. It was found that atmospheric scattering is a significant factor for $\tau > 0{\cdot}01$, and for an albedo of 0·80 (snow cover) the albedo correction term is significant for $\tau > 0{\cdot}05$. For usual albedos ($\tau \leqslant 0{\cdot}25$) the albedo correction term is only significant for $\tau > 0{\cdot}15$. A.

551.593.9 : 535.681

9847. Measurements of sky luminance distribution at Stockholm. R. G. Hopkinson. *J. Opt. Soc. Amer.*, **44**, 455–9 (*June*, 1954).

The fully overcast sky appears to have the same luminance distribution in the latitude of Stockholm (60°N approximately) as it has in the latitude of London (50°N approximately), Washington (U.S.A.) (40°N approximately), and elsewhere. It would therefore appear that the Moon and Spencer formula for the luminance distribution of the completely overcast sky can be taken to apply to northern latitudes. The blue-sky brightness distribution agrees with other similar measurements and with a formula derived from first principles by G. Pokrowski, but less well with Pokrowski's own modified formula which he adjusted to agree with measurements made in Moscow. A.

551.594.14

9848. Research on atmospheric radioactivity. H. Garrigue. *C.R. Acad. Sci.* [*Paris*] **238**, 2074–5 (*May* 24, 1954) *In French.*

In flight at 2800 m, traces of radioactive particles were gathered, by means of a corona effect similar to that of Sella, and of long period, on April 24, 1954. At Puy-de-Dôme (1465 m) after a fall of rain and snow on May 3–4, 1954, samples of the fallen residue showed very feeble radioactivity of period 10 days or more. This radioactivity of the airborne particles was independent of their probable natural electrical charge and mobility and was indicative of an "atomic" cloud. R. S. READ

551.594.5

9849. Theory of the aurora based on magnetic self-focusing of solar ion streams. W. H. Bennett and E. O. Hulburt. *Phys. Rev.*, **95**, 315–19 (*July* 15, 1954).

It is assumed that the sun emits a jet of an electrically neutral mixture of fast electrons and positive ions, and that the space between the sun and earth is filled with an ionized, electrically neutral gas. As the jet proceeds the fast electrons are slowed down and scattered by encounters with the space ionization, being continually replaced by slow electrons from space. The stream of positive ions continues as an electric current, but at all times the stream and surrounding gas are closely electrically neutral. Due to the magnetic field of the electric current the fast moving positive ions are continually compressed into the stream and the fast electrons and slower ions are ejected from the stream. This is "magnetic self-focusing." The stream develops into a narrow core which if correctly aimed enters the earth's magnetic field and is diverted to auroral zones according to the calculations of Störmer. Meinel's observations indicate that the primary solar particles in the stream are mainly protons of speed greater than 3×10^8 cm sec^{-1}. A speed of order of 10^{10} cm sec^{-1} of the protons is required for correct Störmer orbits into auroral latitudes and penetration to 60 to 80 km levels in the upper atmosphere. For a stream which carries sufficient energy for an aurora, the density of space ionization between the sun and earth is calculated to be at least 10^{-5} electron ion pairs per cm^3 to support magnetic self-focusing and not more than 10^9 pairs per

cm^3 for the fast protons to be able to reach the earth. It is suggested that the auroral rays are not the solar proton stream but are formed when the protons are stopped in the upper atmosphere. Due to the charges and absorbed energy of the protons, oxygen and nitrogen particles of the atmosphere are ejected outward to great heights along the lines of magnetic force and form the auroral rays and streamers. A.

551.594.5 : 535.338·4

9850. Intensity distributions in nitrogen bands excited in auroras and by high-energy protons and hydrogen atoms. L. M. Branscomb, R. J. Shalek and T. W. Bonner. *Trans Amer. Geophys. Un.*, **35**, 107–13 (*Feb.*, 1954).

Nitrogen negative and second positive band spectra have been excited by 100-kV protons and hydrogen atoms from the Rice Institute van de Graaff accelerator. The intensity distributions in the vibrational bands are compared with spectra produced in controlled laboratory experiments by canal rays and electron impact, with auroral spectra, and with results of theoretical calculations. Excitation of second positive bands by high-energy neutral hydrogen atoms and of the negative bands by both neutral hydrogen and protons show the expected marked increase in the rate of population of high vibrational states. Theories for the excitation of the auroral bands are discussed in the light of these results and of theoretical considerations. A.

551.594.51

9851. Rotational temperatures of auroral nitrogen bands. W. Petrie. *J. atmos. terrest. Phys.*, **4**, 5–9 (*Sept.*, 1953).

Auroral spectrograms of dispersion 42–28 Å/mm have been analysed with a recording microphotometer. Rotational temperatures were determined from the profiles of Vegard–Kaplan and Negative Group nitrogen bands, and found to be in the range 450–750°K. It now appears that spectroscopic, rocket and radio results are in reasonable agreement. A.

551.594.6

9852. The reception of atmospherics at high frequencies. F. Horner. *J. atmos. terrest. Phys.*, **4**, 129–40 (*Oct.*, 1953).

Observation of the amplitudes of atmospherics received in the high-frequency band offers a possible method of assessing the distances of their sources. In a preliminary investigation of the potentialities of the technique, atmospherics have been recorded simultaneously at two frequencies in the upper part of the h.f. band. Reception would be expected at both frequencies from sources within ground-wave range (about 100 km). At rather greater distances, such that the receiving point is in the skip zone for both frequencies, no reception should be possible. There should then be a zone from which there should be reception on the lower frequency only, and at greater distances energy should again be received at both frequencies. The preliminary results conform generally with this pattern, and the boundaries of the various zones are in agreement with the ionospheric data derived from vertical incidence soundings. The sources of the atmospherics observed were located by use of the network of direction finders operated by the Meteorological Office. It is concluded that the technique forms a basis for routine estimation of the distances of storms and merits further examination to determine more precisely the accuracy which can be achieved and to overcome certain practical difficulties in the observations. A.

551.594.7 : 621.396.11

9853. A preliminary survey of tropospheric refractive index measurements for U.S. interior and coastal regions. C. M. Crain, J. R. Gerhardt and C. E. Williams. *Trans Inst. Radio Engrs Prof. Group on Antennas and Propagation*, **AP-2**, 15–22 (*Jan.*, 1954).

Summarizes the results of approx. 700 tropospheric refractive index soundings carried out between July, 1952, and December, 1952, using aircraft-mounted direct-reading refractometers. Extensive observations up to heights of 25 000 ft have been made in the southern Ohio region and off the U.S. East and West Coasts. Preliminary statistical analyses on the occurrence of standard and non-standard average gradients are presented together with qualitative meteorological correlations. The existence of large-scale index variations near certain cloud boundaries is confirmed and these are tentatively explained in terms of the contrast between the free air refractive index and that of a vertically moving air current having a refractive index representative of some lower atmospheric level. A.

BIOLOGY 57/59

578.087.78

9854. Construction and properties of sub-miniature pressure pickups. C. J. D. M. Verhagen, J. P. Palm, J. van der Ster, W. van Genderen and B. P. T. Veltman. *Appl. sci. Res. B*, **3**, *No.* 6, 409–16 (1954).

Two manometers for dynamical measurements (up to frequencies of the order of 50 c/s) are described which were developed for measuring blood pressure in cardiac catheterization studies and for measurements in pneumatic controllers respectively. The principle of a differential transformer was used in which the core was entirely held by a phosphor bronze membrane. The diameter of the blood pressure manometer is 2 mm (fitting to No. 6 catheter), its length 10 mm The characteristics of the manometers are given. A

581.14 : 535.371

Light emission by germinating plants. *See Abstr.* 9120

591.12.087.9

9855. A new apparatus for the partitioning of expired air of small animals. P. E. Palm, K. M. Cook, J. H. U. Brown and T. Hatch. *Rev. sci. Instrum.*, **25**, 576–9 (*June*, 1954).

A mechanical respirator with synchronized respiratory partitioning valve for guinea pigs is described. This apparatus is used for the separate determination

of dust retention in the upper respiratory tract and deep lung spaces. The partitioning valve separates the exhaled air into three fractions beginning with the earliest portion of upper respiratory air and continuing to the terminal fraction of deep lung air. The same volumetric fractions from successive exhalations are collected over a test period of any practical duration. In principle, the apparatus is similar to one previously described [Abstr. 4978 (1951)] for the study of dust retention in human lungs. A.

MEDICAL SCIENCE . HUMAN PHYSIOLOGY 61

612.17 : 518.5

9856. Dynamic heart-body simulator. E. FRANK. *Rev. sci. Instrum.*, **25**, 611–15 (*June*, 1954).

A high-speed electronic analogue computer is described which is a useful research tool in the analysis of body-surface voltages produced by a fixed-position, variable-moment heart dipole. The simulator is capable of generating a wide variety of electric signals resembling present-accepted estimates of heart-vector functions, forming body-surface voltages from these signals using empirically determined coefficients, and manipulating these voltages so as to produce quantities of the type commonly dealt with in electrocardiography. The basic theory underlying the simulator is summarized, and a description of its components is presented. Typical uses are given for the case of studies using a heart dipole immersed in a homogeneous model of the human torso. The advantages and flexibility of this device are discussed along with its possible future application in the analysis of human heart signals. A.

612.843.31

9857. Chromaticity-confusion contours in a complex viewing situation. R. M. HALSEY AND A. CHAPANIS. *J. Opt. Soc. Amer.*, **44**, 442–54 (*June*, 1954).

This experiment measured confusion contours for 58 standard colours distributed throughout the C.I.E. constant-luminance diagram. Matches were made to these standards from an assortment of 342 heterogeneous colours arranged in a display which presented 171 of them simultaneously. The viewing conditions approximate those found in certain complex display situations. Twenty subjects were used in the experiment. Each subject was required to indicate those colours on the display board which provided satisfactory matches for each of the standard colours. Contours on the C.I.E. diagram are drawn to show the percentage of times various chromaticities were confused. From these contours colours are selected which can be discriminated with high levels of accuracy and so are suitable for coding qualitative and quantitative information. In general, the contours follow trends suggested by extrapolation from precise threshold data. A.

612.843.31

9858. H–R–R polychromatic plates. L. H. HARDY, G. RAND AND M. C. RITTLER. *J. Opt. Soc. Amer.*, **44**, 509–23 (*July*, 1954).

A description is given of the H–R–R plates and evaluation of the test as a device (*a*) to separate those with defective colour vision from those with normal colour vision, (*b*) to classify the type of defect (qualitative diagnosis) and (*c*) to indicate the extent of the defect (quantitative diagnosis). For this evaluation 780 subjects were used, not selected on the basis of a statistical survey. The H–R–R plates are shown to be in complete agreement with the A.O. test (revised selection) in separating the subjects into two groups: 150 with defective and 630 with normal red-green vision. The test agrees remarkably well with the Nagel anomaloscope in classifying the subjects with defective red-green vision into deutan and protan types. It rates 23% of these subjects as having mild defect, 31% as having medium defect and 46% as having strong defect. For the subjects with defective colour vision, a detailed comparison is presented of the qualitative classifications into deutan and protan types yielded by the H–R–R plates with those made by the Nagel anomaloscope, the Ishihara test and the dichotomous test. A further comparison is made for these subjects between the quantitative estimates of extent of defect by the H–R–R plates and performance on various aptitude tests which were designed to select those colour-defective persons who can meet the colour requirements of specific but different tasks. It is shown that the percentage who pass these tests significantly and consistently decreases as the severity of defect shown by the H–R–R plates increases. The practical importance of a simply administered, comprehensive test, such as is provided by the H–R–R plates, to vocational selection and guidance is discussed, and an example given of their application in the radio and television industry. A.

612.843.37

9859. An analysis of Taylor's data on relative luminous efficiency of various colors. C. S. BRIDGMAN. *J. Opt. Soc. Amer.*, **44**, 394–6 (*May*, 1954).

Taylor's data on the relative luminous efficiency of various filter colours at intermediate intensities have been examined for evidence of rod-cone interaction. Shorter wavelengths show relatively less evidence of combined rod-cone function, with the "transition range" limited to approximately one log unit of intensity. Longer wavelengths show evidence of a broader transition range. Relationships of this sort are of significance to the theoretical basis of intermediate-level photometry, and to the understanding of the transition between rod and cone vision. A.

612.843.611

9860. Variation of integrative actions in the retinal system: an adaptational phenomenon. G. VAN DEN BRINK AND M. A. BOUMAN. *J. Opt. Soc. Amer.*, **44**, 616–20 (*Aug.*, 1954).

The interaction of subliminal effects arising in the retina from two stimuli presented at adjustable time and distance apart from each other is studied (with the aid of measurements of frequencies of seeing) for each stimulus separately and for the combined flash. The chance for successful interaction as a function of time and distance between the stimuli is deduced quantitatively. Experiments refer to red and green flashes on red and green adapting fields, in peripheral and foveal vision. Except for integrate capacity in

space in the fovea, a considerable decrease in these capacities is demonstrated for higher levels of adapting brightness. The amplitude of variation in sensitivity during adaptation is estimated. A.

612.85

9861. The measurement of human channel transmission characteristics. W. A. MUNSON AND J. E. KARLIN. *J. Acoust. Soc. Amer.*, **26,** 542–53 (*July*, 1954).

Uses concepts in information theory and psychophysics to provide a basis for the quantitative measurement of certain communication properties of the human being. Pt I of the paper discusses testing techniques in which binary signals were used for measuring information transmitted over a human communication channel. Pt 2 proposes a model of this channel for investigating the factors which influence this information rate. The model involves three parameters: the signal level, the noise level of the human circuits and the discriminant level of the human circuits. Some illustrative experimental measurements of these parameters are included. A.

612.85

9862. Some further experiments upon the recognition of speech, with one and with two ears. E. C. CHERRY AND W. K. TAYLOR. *J. Acoust. Soc. Amer.*, **26,** 554–9 (*July*, 1954).

A number of objective tests are described, directed towards the general problem concerning the faculty of perceiving only one acoustic world under normal conditions (in spite of having two ears) and yet, if the ears be stimulated by different signals, artificially, attending to one or the other of them. The tests have been made with continuous speech (readings from light fiction) and the results assessed statistically. The first tests aim at measuring the reaction time τ required to "switch the attention" from one ear to the other, as assessed by perception of the words of the message. A second set of tests show that only one speaker is perceived, as a "gestalt," when the ears are stimulated by similar messages but with a delay between them exceeding 20 times that ever experienced in real life by virtue of binaural directivity. A.

612.85 : 534.321

9863. Observation of the Tartini pitch produced by "sin $9x$ + sin $13x$". M. F. MEYER. *J. Acoust. Soc. Amer.*, **26,** 560–2 (*July*, 1954).

The combination of the physical tones of the frequency ratio 9 : 13 makes the secondary pitch 5 clearly audible; but neither the difference tone pitch nor the summation tone pitch, nor any so-called aural harmonic is audible. The theoretical discussion is based on the hydraulic (non-vibratory) mathematics of cochlear mechanics. A.

612.85 : 534.831

9864. Contributions to the question of hearing safety in the case of noise fatigue of pathological and normal ears in traffic. F. J. MEISTER. *Acustica*, **4,** 421–7 (1954) [=*Akust. Beih., No.* 1 (1954)] *In German.*

Experiments have been made to find out how much directional hearing (right-left perception) in case of hearing loss is impaired under influence of a noise of mean traffic level. To have a better interpretation of the results, the author makes some further investigations on the problems of adaptation, annoyance and fatigue under traffic and industrial noise, and especially on the shift of the sensation threshold and the velocity of adaptation under influence of a noise. A.

612.858

9865. The audibility threshold for sound phenomena with various frequency spectrum widths. G. GÄSSLER. *Acustica*, **4,** 408–14 (1954) [*Akust. Beih., No.* 1 (1954)] *In German.*

An attempt is made to find out how the ear sums up complex sounds and forms the threshold stimulus for the limit of audibility. The result is that the threshold value of a sinusoidal tone represents the general threshold of audibility supposing that the threshold pressure level is regarded as the effective level within a certain frequency band of definite width, the "coupling width." This proves true not only for the normal threshold of audibility but also in the presence of masking sounds. A.

612.858

9866. The masking of small-bandwidth noise by sinusoidal tones. E. ZWICKER. *Acustica*, **4,** 415–20 (1954) [*Akust. Beih., No.* 1 (1954)] *In German.*

Masking of small bandwidth noise by two sinusoidal tones of equal level but variable frequency separation has been studied. There results quite clearly a critical frequency distance of the masking tones dividing the regions of constant and variable masking. This does not depend on the pressure level of the masking tones. This separation amounts to about 90 c/s in the region below 500 c/s, and to about 20% of the medium frequency above 500 c/s. A.

614.898

9867. Betatron X-rays: how much concrete for shielding? F. S. KIRN AND R. J. KENNEDY. *Nucleonics*, **12,** 44–8 (*June*, 1954).

Experiments on the attenuation of 6–38 MeV betatron X-rays in concrete slabs are described. Comparison with theory indicates that the results may be extrapolated to calculate, to a good degree of approximation, the attenuation of radiation up to 100 MeV. L. R. SHEPHERD

614.898

9868. Radiological safety in cathode-ray sterilization. S. LEVIN. *Nucleonics*, **12,** 54–7 (*June*, 1954).

Data on the bremsstrahlung produced by high-energy electrons is summarized and the calculation of the necessary shielding against this and scattered electrons from cathode-ray sterilization equipment is discussed. L. R. SHEPHERD

616–073.75 : 771.534.5

9869. Refinements in static densitometry. M. MARCHAL AND M.-T. MARCHAL. *C.R. Acad. Sci. [Paris]* **238,** 2560–2 (*June* 28, 1954) *In French.*

The system for measuring the radiographic density of a lung field in an X-ray picture, is extended to provide continuous densitometry during respiration. The patient is placed as for screening, and a photocell on the viewing side of the screen records light changes (i.e. changes in transmitted X-rays) as the patient breathes. These changes are recorded on a cathode-ray tube screen equipped with a camera. D. V. MABBS

TECHNICAL MATERIALS 66/67

666

9870. Variation of the physical properties of glass with time in the transformation range. R. W. DOUGLAS. *G.E.C. J.*, **21**, 187–96 (*July*, 1954).

A semi-technical discussion of existing knowledge concerning the changes in density, refractive index and viscosity of silicate glasses due to structural changes associated with a varying temperature.

R. O. DAVIES

666 : 535.81

Physical properties of five optical glasses. *See Abstr.* 9161–4

669 : 548

9871. Progress in metal physics. Volume 5. Edited by B. CHALMERS AND R. KING. *London: Pergamon Press* (1954) vii + 324 *pp.*

For Volume 4, see Abstr. 3779 (1953). For abstracts of separate chapters see Abstr. 8959, 9646, 9678, 9734–5 (1954). E. P. WOHLFARTH

PHOTOGRAPHY 77

771.35

9872. On the focusing of rotating-mirror framing cameras. A. S. FILLER. Letter in *J. Opt. Soc. Amer.*, **44**, 506 (*June*, 1954).

The optical system of a framing camera has to focus the object upon the revolving mirror and also the entrance slit upon the relay lens slit. Conventional arrangements require two lenses to be moved to retain correct focus for objects at different distances. A system is described in which only one lens, a field lens, has to be moved. R. W. FISH

771.4 : 535.84

Reproduction of images with amplification of contrast. *See Abstr.* 9168

771.53

9873. The density, granularity and silver content of photographic film exposed to ionizing radiations. E. H. BELCHER AND G. SPIEGLER. *J. photogr. Sci.*, **1**, 86–9 (*May–June*, 1953).

The diffuse density, specular density and silver content of photographic film exposed to ionizing radiations in the energy-range 0·1–1 MeV have been studied. No significant variation with energy in the form of the characteristic curve could be observed within this energy range. The relationships between specular density, diffuse density and silver content were identical within the limits of experimental error for all types of radiations studied and for visible light. The linear relationship between the logarithm of the specular density and that of the diffuse density, previously observed in the case of exposure to visible light, was found also to hold for ionizing radiations. A linear relationship between silver content and specular density was found to apply over a wide density range. A.

771.53 : 535.39

Gloss measurement and tolerance of photographic paper. *See Abstr.* 9132

771.534.5 : 535.89

A mosaic filter daylight source for aerophotographic sensitometry in the visible and infrared region. *See Abstr.* 9169

778.34 : 537.591.8

Cosmic ray phenomena in a new nuclear emulsion having a fine grain. *See Abstr.* 9372

778.34 : 539.18

9874. Measurement of the mass of charged particles recorded in nuclear emulsions without support [pellicles] by grain counting. T.-F. HOANG. *C.R. Acad. Sci. [Paris]* **238**, 1790–2 (*May* 3, 1954) *In French.*

The grain density of each of 20 π-mesons recorded in a 600 μ nuclear emulsion pellicle was measured as a function of the residual range, each particle having a range greater than 2 cm in the emulsion. The grain density was shown to be proportional to the rate of energy loss of the particle dE/dR for values of β between 0·3 and 0·7. This linear relationship enables dE/dR to be calculated in a general case and, using the empirical equation $E/M = a(R/M)^b$ the mass M of the particle can be determined. A value of $M = 276{\cdot}5$ was obtained as the mean mass of the 20 π-mesons measured, and the values for the masses of three τ-mesons were $M = 980$, 920 and 940 respectively. An accuracy of 6% is obtainable by this method. A. C. COATES

778.534 : 532.528

9875. Cinematographical photographs of injected water vapour. W. GÜTH. *Acustica*, **4**, 445–55 (1954) [= *Akust. Beih., No.* 1 (1954)] *In German.*

Describes the construction of a cinematograph for a picture frequency of 40 000 . . . 65 000 per second, used to observe the details of the condensation of water vapour. The vapour, blown into cold water by means of a nozzle, condenses in the form of bubbles. The course of the condensation with respect to time is found to be in quite good agreement with a formula calculated by Rayleigh. By means of the optical Toepler striae method the author succeeded in making visible the shock wave radiated at the bursting of a bubble. A.